Ed Campion
Headquarters, Washington, D.C.
(Phone: 202-358-1780)

James Hartsfield
Johnson Space Center
(Phone: 713-483-5111)

April 4, 1994

RELEASE: 94-028

LAUNCH ADVISORY -- STS-59 LAUNCH RESCHEDULED TO APRIL 8TH

Space Shuttle managers today decided to delay the launch of STS-59 to allow additional inspections of metallic vanes in the high pressure oxidizer preburner pump volute housings of Endeavour's main engines.

The inspections are expected to add at least one day to the launch preparations, and managers will review the findings once the inspections are completed. A launch window for STS-59 on April 8th opens at 8:06 a.m. EDT.

The inspections are being performed after similiar main engine parts were found to be out of specification by about 30 thousandths of an inch regarding measurements of the radius of the metallic vanes. The vanes direct the flow of liquid oxygen as it is fed into the high pressure oxidizer turbopumps on the engines. The radius is a measure of the curvature of the metal, and a sharper curvature could reduce the tolerance of the metal to fatigue cracking.

The out-of-specification measurements were found on a housing undergoing proof testing at Rockwell's Rocketdyne Division, the main engine manufacturer. Some other preburner housings were then found to have similiar curvatures.

However, in more than 8,330 minutes of Space Shuttle Main Engine operations to date, no preburner housings have been found to have fatigue cracks. In addition, cracks have never been found following proof testing of the housings, tests that subject the parts to much more severe pressures than experienced during flight. Due to the out-of-specification measurements, managers decided an inspection of the preburner housings installed in Endeavour's main engines to determine their radius would be prudent.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Debra J. Rahn
Headquarters, Washington, D.C.
(Phone: 202/358-1639)

For Release
April 5, 1994

EDITORS NOTE: N94-28

INTERNATIONAL SPACE STATION ACCOMPLISHMENTS AND RUSSIAN PARTICIPATION DISCUSSED

The heads of the space agencies involved in the International Space Station, the Canadian Space Agency (CSA), the European Space Agency (ESA), the National Space Development Agency of Japan (NASDA), the Russian Space Agency (RSA) and the National Aeronautics and Space Administration (NASA) met in Washington, D.C. on April 5, 1994. The joint statement, summarizing the results of the meeting, is being issued today by all the participants.

Joint Statement -- Space Station Heads of Agencies Meeting

The heads of the space agencies involved in the International Space Station -- the Canadian Space Agency (CSA), the European Space Agency (ESA), the National Space Development Agency of Japan (NASDA), the Russian Space Agency (RSA) and the U.S. National Aeronautics and Space Administration (NASA) -- met in Washington, D.C., on April 5, 1994. This was the first meeting of this group since Russia accepted the collective invitation to join the International Space Station partnership in December 1993. The heads of agencies evaluated positively the accomplishments since December 1993 to define the International Space Station Program and to bring Russia officially into the program.

The heads of agencies discussed the outcome of the recently completed Space Station System Design Review (SDR). CSA, ESA and NASDA noted the remarkable progress made to accommodate Russia as a new partner and to satisfy the interests of all the partners in the new program structure, and they commended NASA for its efforts to improve program efficiency and to clarify the potential for additional partner contributions. The heads of agencies agreed that the station configuration at SDR possesses increased robustness, has more capabilities and will become available to users at an earlier date. They noted the importance of defining in more detail the utilization strategy for the Space Station, particularly with regard to the Russian contribution. They also noted significant progress towards achieving a more beneficial distribution of operations roles among the partners.

- more -

The heads of agencies acknowledged the major advances made collectively over the past three months in bringing Russia into the International Space Station Program. Activities at the government and agency levels have paved the way for negotiation of the agreements necessary to formalize Russia's inclusion in the program. All expressed support for proceeding with these negotiations, scheduled to start in late April, in an expeditious manner. The heads of agencies also noted the importance of concluding, in a timely manner, the interim agreement between NASA and RSA to facilitate Russia's early participation in program management mechanisms. They share the determination that the International Space Station Program will be accomplished without further delay.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Terri Sindelar
Headquarters, Washington, D.C.
(Phone: 202/358-1977)

For Release
April 5, 1994

RELEASE: 94-56

NASA FOSTERS AEROSPACE EDUCATION IN ARKANSAS

NASA today announced its intent to grant the Arkansas Aerospace Education Center $500,000 to implement its Technology Industry Resource Project to help develop enrichment opportunities for secondary school students statewide in mathematics, applied sciences and technology.

The new Aerospace Education Center is a unique collaboration of public and private interests to create a model education center, employing the latest teaching methods oriented to aerospace technologies. The center will include the Arkansas High Technology Training Center, an aerospace museum, a public library and an IMAX theater.

Students from across the state will experience new and challenging assignments in their classrooms and in the center's classrooms, in the museum, at the IMAX theater and in work-related projects provided by partners in business and industry.

The Aerospace Education Center supports the nation's education goals and the education reform movement. Recent legislation, "Goals 2000," was passed by Congress to establish the nation's education goals.

"NASA has been a supporter of the nation's education reform initiative, and this project will further the agency's efforts to support education reform," said Frank Owens, Director of NASA's Education Division, Headquarters, Washington, D.C.

"The Technology Industry Resource Project that NASA is supporting addresses two priorities of the reform effort. The first is training for high technology careers and the second is supporting life-long learning," said Owens.

- more -

Technology Industry Resource Project

The Technology Industry Resource Project offers high school students the opportunity to learn about mathematics, applied sciences and technology through direct, "real world" experiences.

The goal is to interest and involve students in applied technology programs using these "real world" experiences and curriculum enhancement to interest students in pursuing high-technology career opportunities.

High school students will be offered field trips to and apprenticeships with industry and students will learn from guest lectures and "visiting scientists" who will visit individual schools and lecture at the center.

The grant also will be used to create curriculum enhancement modules to help teachers present applied science programs in the classroom in an interesting and effective manner. These materials will include workbooks, videos, computer simulations, working models and multimedia presentations. These support materials will provide model curriculum enhancements that can be duplicated for use in classrooms nationwide.

Other print and multimedia materials will be developed for use by teachers as preparation for and follow-up to the center's field trips, lectures and other aspects of the project.

The Arkansas Aerospace Education Center

The Aerospace Education Center is a public and private partnership for education to help prepare students for jobs in existing and emerging technology fields. The center is co-located with the aviation industries at the Little Rock Regional Airport.

The center is operated by the Arkansas Department of Education -- General Education Division, Vocational Education Division and the Central Arkansas Library System -- and is supported by several Arkansas colleges and universities including the University of Arkansas at Little Rock, which is the lead university in the Arkansas Space Grant Consortium.

In 1993, the National Science Foundation awarded Arkansas a Statewide Systemic Initiative Grant for science instruction. In conjunction with this program the Arkansas Department of Higher Education will collaborate with the center to develop a visiting scientist program to reach all 7th grade students in Arkansas each year.

- more -

The Arkansas Aviation Historical Society is directly involved in creating and maintaining the Museum of Aviation History and the IMAX Theater. The Industrial Development Commission is involved with the Arkansas High Technology Training Center staff to help train future work forces and recruit high technology companies to Arkansas. The Arkansas Aviation Aerospace Commission and the Arkansas Science and Technology Authority serve on the advisory board appointed by the Governor.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Ed Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1780)

For Release
April 5, 1994

Kyle Herring
Johnson Space Center, Houston
(Phone: 713/483-5111)

RELEASE: 94-57

SHUTTLE ASTRONAUT GRABE MOVES TO ORBITAL SCIENCES CORP.

Veteran Space Shuttle Astronaut Ronald J. Grabe will leave NASA and the Air Force to join Orbital Sciences Corp., Dulles, Va., effective April 11.

Grabe, a four-time Shuttle flyer -- twice as pilot and twice as commander -- will retire from the Air Force with the rank of Colonel and become Vice President, Business Development for Orbital Sciences Corp.'s Launch Systems Group. At OSC, Grabe will assist in the development of launch vehicles and marketing strategy. He also will serve as the link with customers on future projects.

"We certainly will miss Ron. Not only is he a superb Shuttle commander, but he is a great technical manager as well," Flight Crew Operations Director David C. Leestma said. "It's a credit to the space industry that Ron's wealth of experience and knowledge will not be lost."

Grabe's first Shuttle flight in October 1985, STS 51-J, was a dedicated Department of Defense mission on the maiden voyage of Shuttle Atlantis. His second flight in May 1989 was on the STS-30 mission of Atlantis to deploy the Magellan probe, which has mapped more than 95 percent of the surface of Venus since arriving at the planet in 1990. The spacecraft continues to gather data on atmospheric conditions, as well as the planet's magnetic field.

Grabe's third mission in January 1992 was aboard Discovery on the STS-42 flight. The first International Microgravity Laboratory Mission (IML-1) was his first as commander. The crew worked in two shifts in the Spacelab module investigating the effects of microgravity on materials processing and life sciences in the course of more than 80 experiments.

- more -

In June 1993, Grabe served as Commander of the STS-57 mission aboard Endeavour. The multi-faceted mission included the first flight of the pressurized Spacehab module carrying 22 flight experiments in materials processing and life sciences. In addition, Grabe's crew retrieved the free-flying European Retrievable Carrier previously deployed during the STS-46 mission in August 1992. A spacewalk was conducted during the flight to evaluate various techniques for use on future missions.

Most recently, Grabe has served as a member of the Vehicle Review Board for the International Space Station.

"Ron has been a talented and insightful team member from the early days of Space Shuttle through four highly successful space flights as a crew member," said Robert L. "Hoot" Gibson, Chief of the Astronaut Office. "He has contributed greatly to our nation's space efforts and we wish him every possible success in his future endeavors."

Grabe was selected to be an astronaut in 1980. Prior to joining NASA, Grabe was an instructor at the U.S. Air Force Test Pilot School at Edwards Air Force Base, Calif. Since graduation from the Air Force Academy in 1966, he has logged more than 5,500 hours flying time in the F-100, F-111 and A-7 aircraft . Grabe flew 200 combat missions while assigned to the third Tactical Fighter Wing at Bien Hoa Air Base in Vietnam. He also served as a Royal Air Force Exchange Test Pilot at Boscombe Down, England.

In addition to his bachelor of science degree in engineering science from the Air Force Academy, Grabe studied aeronautics as a Fullbright Scholar at Technische Hochschule, Darmstadt, Germany. He was born in New York City in 1945.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Michael Braukus
Headquarters, Washington, D.C.
(Phone: 202/358-1979)

For Release
April 7, 1994

RELEASE: 94-58

NASA ANNOUNCES MICROGRAVITY RESEARCH GRANTS

NASA has selected 39 researchers to receive 3- to 4-year grants for microgravity combustion research totaling more than $13 million. Thirty-three of the grants are for Earth ground-based research, while the remaining six are flight definition efforts.

Sponsored by NASA's Office of Life and Microgravity Science and Applications, Headquarters, Washington, D.C., this research offers investigators the opportunity to take advantage of a low-gravity Earth environment to improve understanding of fundamental physical and chemical processes associated with combustion phenomena which often are masked by normal gravity conditions.

Understanding how combustion occurs in the microgravity environment of spaceflight may increase knowledge of how flames spread on Earth and may contribute to improvements in all types of fire safety and control equipment. It also may contribute to the development of more efficient and environmentally-safe world fuel resources.

The investigators will have NASA's microgravity research facilities -- drop-tubes, drop-towers, aircraft flying parabolic trajectories and sounding rockets -- at their disposal. The flight-definition investigators' work eventually may lead to flight experiments in low-Earth orbit

NASA received 98 proposals in response to its microgravity research announcement. These proposals were peer-reviewed by non-NASA scientific and technical experts. In addition, those proposals selected for flight definition were reviewed for engineering feasibility by a team from NASA's Lewis Research Center, Cleveland.

\- end -

Editor's Note: A list of the grant recipients is available to media representatives by sending fax request to the NASA Hq. Newsroom at 202/358-4335 or -4210.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Dwayne C. Brown
Headquarters, Washington, D.C.
(Phone: 202/358-0547)

James Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

For Release
April 11, 1994

N94-30

NASA COMMUNICATIONS TECHNOLOGY TESTING WORKSHOP SCHEDULED

A one and a half-day workshop will be held at NASA's Goddard Space Flight Center (GSFC), Greenbelt, Md., April 14 and 15, to describe how private industry, universities and other government agencies can utilize NASA's Tracking and Data Relay Satellite System (TDRSS) to test satellite communication technology via the Mobile Satcom TDRSS (MOST) Experiment Program.

In addition, the workshop will describe the operation of NASA's TDRSS, outline NASA and user responsibilities and describe the program's proposal process. Lionel Johns, Associate Director for Technology, Office of Science and Technology Policy, will provide the keynote address.

The MOST program is designed to afford an opportunity for private industry to conduct experiments and demonstrations of future telecommunications technologies via TDRSS. Potential tests could include rural and remote business or personal communications, ground transportation tracking and messaging, commercial air carrier fleet control and communications that include telephone service, facsimile and personal paging services.

The workshop will be held at GSFC's Building 3 Auditorium beginning at 8 a.m. EDT. Media interested in attending should call the GSFC Public Affairs Office at 301/286-8955 for further information and a workshop agenda.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

David E. Steitz
Headquarters, Washington, D.C.
(Phone: 202/358-1730)

Ernie J. Shannon
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/544-0034)

For Release
April 12, 1994

RELEASE: 94-59

NASA SIGNS TECHNOLOGY AGREEMENT WITH AEROSPACE CONSORTIUM

A technology reinvestment program (TRP) agreement to develop hybrid rocket motor technology was signed April 7 between NASA's Marshall Space Flight Center, Huntsville, Ala., and a consortium of three U.S. aerospace companies.

Marshall's newly-established Technology Transfer Office, under the direction of Harry G. Craft, will manage this technology development initiative. "We see this as a major step in a new way of doing business -- government and industry in a partnership to create new technologies and commercial ventures," Craft said. "This agreement is an important step in stimulating the transition of technology to the private sector and enhancing U.S. competitiveness."

The Hybrid Technology Project (HyTOP) Consortium consists of Martin Marietta Manned Space Systems, New Orleans; United Technologies Corporation's Chemical Systems Division, San Jose, Calif.; and the American Rocket Co., Ventura, Calif. The agreement is between NASA, with the Marshall Technology Transfer Office in a management role, and the HyTOP members.

Under TRP guidelines, the federal government provides up to 50 percent of the funding towards development of technologies that can be used in both a government and a private sector setting. In this case, TRP will provide $10.4 million dollars during the 30-month duration of the project. The consortium will provide the remaining, approximately $12 million.

- more -

Hybrid rocket motors consist of elements from both solid and liquid fuel rockets and are safe, non-explosive and environmentally friendly. The cooperative agreement calls for the consortium to build and test 2 H250K hybrid qualification motors with 250,000 pounds of thrust. The motors will be cast and assembled at Vandenberg Air Forces Base, Calif., and tested at the Phillips Laboratory, Edwards Air Force Base, Calif.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Beth Schmid
Headquarters, Washington, D.C.
(Phone: 202/358-1760)

For Release

April 14, 1994

RELEASE: 94-60

100 GIRLS, AGES 9-15, TO JOIN NASA HQ WORKFORCE ON APRIL 28

The nationwide "Take Our Daughters to Work" program, initiated last year by the Ms. Foundation for Women, is coming to NASA Headquarters on Thursday, April 28, bringing with it 100 girls ages 9-15. The annual event is devoted to the ideas, problems, spirit and dreams of young girls. The Headquarters program, sponsored by the Federal Women's Program and the Women's Advisory Council, will provide the opportunity for daughters of NASA employees to experience the space agency's Headquarters operations for a day.

After a welcome from NASA's Chief Scientist, Dr. France Anne Cordova, the girls will view the film, "The Dream is Alive," and engage in dialogue with astronauts from the STS-60 SPACEHAB-2 mission. For the remainder of the morning, the girls will be paired with a mentor, a NASA employee who will go about her/his job activities, and the girls can see the kinds of duties NASA technical and non-technical staff are involved in every day. Wherever a mentor goes, whether to a program meeting or to meet with a NASA senior official, a girl will accompany, asking questions and learning more about a space-related career.

During the lunch break, a panel of D.C. Public School teachers will talk about the "Cultural Connection to Math, Science and Technology." The afternoon will feature further dialogue with astronauts and demonstrations of robotic devices, including a Mars micro-soil sampler and a power ratchet tool like the one used on last December's Hubble Space Telescope repair mission. Exhibits will be on display in the Headquarters lobby and the NASA Spacemobile will be present to provide additional "hands-on" exhibits.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Jim Cast
Headquarters, Washington, D.C.
(Phone: 202/358-1779)

Don Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1727)

For Release
April 18, 1994

RELEASE: 94-61

UPDATED MIXED FLEET MANIFEST RELEASED

NASA today released its updated Mixed Fleet Manifest reflecting the flight schedule for Space Shuttle/Space Station missions through Calendar Year 1997 and expendable launch vehicle (ELV) missions through Calendar Year 2001.

Of note in the Space Shuttle/Space Station portion of the manifest is the inclusion of 10 Space Shuttle flights to the Russian Space Station MIR between 1995-1997, representing the first of three phases of International Space Station cooperative activities. Launch of the first Shuttle SPACELAB-MIR mission, STS-71, is scheduled for May 1995.

The new manifest update also includes reflight of the Tethered Satellite System in March 1996, the next Hubble Space Telescope Servicing Mission in August 1997 and the first U.S. element launch of the International Space Station in December 1997.

The manifest also reflects the recently-announced Orbiter Maintenance Down Period decision to modify and refurbish the Shuttle fleet at the Rockwell Space Systems Division, Palmdale, Calif.

The U.S. commercial, expendable launch vehicle fleet continues to provide NASA with a reliable and efficient access to space for a variety of payloads supporting space science missions.

On May 16, 1994, NASA is scheduled to launch its last Scout rocket from Vandenberg Air Force Base, Calif. The Scout launch, NASA's 118th over a 34-year period, will carry the Department of Defense MSTI-2 payload into polar orbit.

- more -

The first NASA flight of the Pegasus rocket, carrying the Total Ozone Mapping Spectrometer, is scheduled for June 22, 1994. The last NASA launch of the Atlas-E ELV will be Sept. 29, carrying the NOAA-J satellite.

The first west coast launch of a Delta-II ELV will be NASA's Polar mission, originally scheduled for later this year (currently under review), while the first west coast launch of the new Atlas IIAS vehicle is scheduled for June 1998, which will carry the EOS-AM-1 satellite.

- end -

NOTE TO EDITORS: Limited numbers of the updated manifest are available at NASA Headquarters and center newsrooms (news media only, please.)

For Washington, D.C.-area media wishing a copy of the manifest to be mailed to you or for messenger pickup, please FAX your request to the HQ Newsroom at 202/358-4210 or 4335.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Ed Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1780)

Lisa Malone
Kennedy Space Center, Fla.
(Phone: 407/867-2468)

For Release
April 19, 1994

RELEASE: C94-j

KSC SELECTS TWO COMPANIES AS LIQUID HYDROGEN SUPPLIERS

Praxair, Inc., Danbury, Conn., and Air Products and Chemicals, Inc., Allentown, Pa., have been selected for negotiations that could lead to the award of 15-year contracts to supply liquid hydrogen to government and contractor facilities.

NASA uses super-cold liquid hydrogen as fuel to help power the Space Shuttle's three main engines during the ascent phase of flight, ground testing and propulsion development. The propellant, also used in the Space Shuttle's onboard fuel cells, is mixed with liquid oxygen to produce power for the Shuttle and drinking water for the astronauts.

To foster competition, the solicitation divided the Eastern United States into two user regions. Region A consists of Stennis Space Center, Bay St. Louis, Miss. Region B includes Marshall Space Flight Center, Huntsville, Ala.; Kennedy Space Center, Fla.; Pratt & Whitney, West Palm Beach, Fla.; Arnold Engineering Development Center, Arnold Air Force Base, Tenn.; and Johnson Space Center, Houston.

The fixed-price requirements contracts have an economic price adjustment feature after the first year. Praxair was selected for Region A, which has an estimated contract value of $150 million. Air Products and Chemicals was selected for the Region B contract with an estimated value of $160 million.

Both contracts will have a vendor preparation period which will commence at contract award and continue until Nov. 30, 1995. Liquid hydrogen deliveries will begin Dec. 1, 1995, and continue through Nov. 30, 2010.

-more-

Praxair will manufacture liquid hydrogen in McIntosh, Ala., and will deliver the fuel by railcars and tanker trucks. New Orleans, La., and Pace, Fla., are the liquid hydrogen manufacturing sites that Air Products and Chemicals will use. The company will deliver the product by tanker trucks.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Dwayne C. Brown
Headquarters, Washington, D.C.
(Phone: 202/358-0547)

Myron Webb
John C. Stennis Space Center, Miss.
(Phone: 601/688-3341)

Morrie Goodman
FEMA, Headquarters, Washington, D.C.
(Phone: 202/646-4600)

For Release
April 20, 1994

RELEASE: 94-62

NASA/FEMA REMOTE SENSING SYSTEM TO SPEED DISASTER RELIEF

NASA and the Federal Emergency Management Agency (FEMA) are exploring a cooperative venture to test and implement a prototype remote sensing system that will acquire, process and distribute photographic-like digital images of disaster-damaged areas to response and recovery officials in near-real time.

"In past disasters, NASA's role has been to assist FEMA by providing aerial photographs to enhance their recovery operations and assessment of area damage. This joint venture will enhance the technology and process to enable FEMA, state and local officials to obtain information more quickly to manage disaster recovery operations," said Fred Gregory, Associate Administrator, NASA's Office of Safety and Mission Assurance, Headquarters, Washington, D.C.

"In addition, the fully implemented technology will be made available to commercial providers of aerial photographic services in order to expand their capability to provide images in near-real time and where needed," Gregory said.

The new system is designed to give response personnel critical information about the location and magnitude of a disaster within hours of acquisition instead of days or weeks. The system will utilize advanced imaging systems, a telemetry system to relay the images to the ground and a mobile ground station to receive and construct aerial maps for use in the field.

- more -

"Since 1974, U.S. Presidents have declared 400 major disasters. This new system will optimize current technology so that fire and police units and first aid and rescue personnel can provide even faster aid and protection to people and property, " said FEMA Director James Lee Witt.

Producing and distributing images of disasters sites using current technology is a slow and labor-intensive process requiring anywhere from 3-10 days to actually get an image to a specific geographical location. The process involves the acquisition of the image, relaying the image to the ground for processing, then distributing the image to rescue personnel. Although the present process is time consuming, the information is invaluable to recovery operations that usually take weeks or months to complete.

Personnel from NASA's Ames Research Center, Mountain View, Calif., and John C. Stennis Space Center, Miss., previously have assisted FEMA and local governments by providing photographs and digital images. Since the early 1980's, NASA's Ames' high altitude ER-2 aircraft has used telemetry to transmit infrared images to ground personnel to map forest fires and to perform damage assessment in Hawaii following Hurricane Iniki. Ames also flew its C-130 aircraft to map the "California Firestorms of 1993" with an infrared scanner that sees through thick smoke.

In August 1992, the NASA Learjet was sent to South Florida to take photographic-like digital images of the areas hit hardest by Hurricane Andrew. The data from the imagery assisted Florida officials in assessing damage done by the storm and provided information to rescue teams about damage to homes, commercial structures and the conditions of roadways.

Recently, NASA's Ames and Stennis centers provided photographs taken over six Midwest cities hard hit by the Mississippi River flood. The ER-2 and C-130 aircraft also surveyed areas of Southern California devastated by the Northridge earthquake. In both cases, the photographs were used to construct maps and update information systems used to distribute critical resources into the affected areas.

"The use of remote sensing imagery has proven critical in FEMA's quick response to recent disasters and will increasingly be used to improve the federal government's situation assessment capabilities," said Witt.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

David E. Steitz
Headquarters, Washington, D.C.
(Phone: 202/358-1730)

For Release
April 20, 1994

RELEASE: 94-63

NASA AWARDS TECHNOLOGY GRANT TO SIERRA COLLEGE

NASA'S Jet Propulsion Laboratory, Pasadena, Calif., has awarded a grant to Sierra College, Rocklin, Calif., for a hands-on community college engineering curriculum as part of the government's technology reinvestment project (TRP).

The TRP grant with Sierra College will allow for the school to design a 2-year curriculum focused on the development of a NASA Getaway Special (GAS) experiment, during which students will design and manufacture a small satellite. A Getaway Special is a small container which is carried in the cargo bay of the Space Shuttle. The project is expected to lead to four new courses in space technology and the development of standard hardware that can be used for multiple applications.

The project will provide students with the experience of building a small satellite and educate the students in the manufacturing expertise sought by American industry. Graduates will benefit from the manufacturing emphasis and should enjoy a significant advantage as they enter an increasingly competitive job market.

The grant represents an example of NASA's efforts to foster improved manufacturing education and training as a means of providing America's future workforce with the skills necessary to compete in the global marketplace.

Under TRP guidelines, the federal government provides up to 50 percent of the funding towards development of technologies that can be used in both government and private sector settings. In this case, TRP will provide approximately half of the $900,000 cost of the grant over a 3-year period. The college and it's research partners will provide the remaining funds.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Barbara Selby
Headquarters, Washington, D.C.
(Phone: 202/358-1983)

Michael Mewhinney
Ames Research Center, Mountain View, Calif.
(Phone: 415/604-9000)

For Release
April 21, 1994

RELEAS: 94-64

NASA PROVIDES PILOT FATIGUE COUNTERMEASURES TRAINING

Responding to growing concerns about aviation safety, NASA scientists have developed a training course that teaches pilots how to combat the adverse effects of fatigue.

A workshop entitled "Alertness Management in Flight Operation" will take place at NASA's Ames Research Center, Mountain View, Calif., May 18-19. Additional workshops will be conducted in August and December.

Developed by the Ames Fatigue Countermeasures Program, the training covers such topics as sleep, circadian rhythms, effects of fatigue on performance and NASA fatigue studies. The training addresses misconceptions about fatigue and recommends ways to offset it.

"The idea is to bring industry people together to talk about fatigue, sleep deprivation and circadian disruption," said Dr. Mark Rosekind, an Ames research psychologist and team leader of Ames' Fatigue Countermeasures Program. "They then can take the information back to their own organizations. It's a great example of technology transfer."

NASA began studying pilot fatigue in1980 after data obtained from the Aviation Safety Reporting System (ASRS) -- a program established in 1975 and administered by NASA in collaboration with the Federal Aviation Administration -- revealed concerns about the issue.

"The ASRS receives many reports from pilots of commuter aircraft alleging that fatigue induced by long duty schedules, compounded by inadequate rest, is often a primary factor in aviation safety incidents," said William Reynard, ASRS Director.

- more -

"When the program started in 1980, there was little information available about the physiology of sleep deprivation and pilot fatigue," said Rosekind. "We've learned enough now to give people concrete information about the physiological factors associated with sleep loss and circadian disruption that underlie fatigue."

American Airlines sent 14 employees to the program's first workshop in February. Both American and Northwest airlines now provide required fatigue countermeasures training for all of their flight crews. Several other airlines and United Parcel Service are considering offering the fatigue training.

-end-

EDITORS NOTE:

Reporters interested in attending the May 18-19 workshop should contact Mike Mewhinney at NASA Ames Research Center, Mountain View, Calif. (415/604-9000).

NASA News

National Aeronautics and Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Brian Dunbar
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Allen Kenitzer
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-2806)

For Release
April 22, 1994

RELEASE: 94-65

50 SCIENTISTS STUDY CANADIAN FORESTS' IMPACT ON CLIMATE CHANGE

U.S., Canadian and European scientists have begun the second phase of a detailed ecological study of the forests of Canada and the role these forests play in climate change.

The Boreal Ecosystem-Atmosphere Study (BOREAS) is a large-scale, ground-based and remote-sensing investigation of how the forests and the atmosphere exchange energy, heat, water, carbon dioxide and other trace gases. The goal of BOREAS is to better understand these exchanges and to improve computer models of these processes, allowing scientists to anticipate the effects of climate change on the region and across planet Earth.

From April 11 to May 2, approximately 50 scientists will study the forests during the annual snowmelt, concentrating on processes in the soil, vegetation and lower Earth atmosphere as the snow melts and Earth's surface warms up.

The second of five intensive campaigns that make up BOREAS, the Focused Field Campaign-Thaw (FFC-T) will take advantage of the just completed, first flight of the Space Radar Laboratory (SRL). Carried aboard the Space Shuttle Endeavour, SRL repeatedly imaged the BOREAS ground sites allowing scientists to compare the spaceborne data with their readings from ground and aircraft investigations.

BOREAS and SRL are components of NASA's Mission to Planet Earth, the agency's coordinated, long-term program to study the Earth as the single environmental system it is. Mission to Planet Earth will combine ground-based, aircraft and satellite data gathered to investigate how Earth's global environment is changing and to distinguish human-induced changes from natural changes. Mission to Planet Earth data, which will be distributed to researchers worldwide, will help people and governments make informed decisions about how they are affecting the environment.

- more -

Of primary interest in the BOREAS thaw campaign is how the sun's energy heats the vegetation, the snow and the underlying soil to produce melting and release gases, including carbon dioxide and methane, into the atmosphere. Increasing atmospheric concentrations of these gases may affect the Earth's climate and weather.

The collected data will be processed and stored at NASA's Goddard Space Flight Center, Greenbelt, Md., for analysis over the next 3 years by the 85 BOREAS science teams. The results will be used to improve models of the global environment, especially how the Earth's climate and vegetation will respond to global change. Global weather-prediction models also should benefit from this work.

Specialized equipment will be used to measure the exchanges of heat, radiation, water and carbon dioxide between the surface and the atmosphere, while aircraft are used to take high-resolution images of the study sites as Earth-observing satellites pass over. Data from the U.S. Landsat, NOAA and GOES satellites and the French SPOT satellites will be used. NASA aircraft -- a C-130, DC-8 and a high-altitude ER-2 aircraft, managed by NASA's Ames Research Center, Mountain View, Calif., — also will overfly the sites with remote-sensing instruments.

Participating agencies in the United States include NASA, the National Oceanic and Atmospheric Administration, the National Science Foundation, the U.S. Geological Survey, the U.S. Forest Service and the Environmental Protection Agency. Canadian participants include the Canada Centre for Remote Sensing, the Canadian Forest Service of Natural Resources Canada, Environment Canada, Natural Sciences and Engineering Research Council, Agriculture and Agri-Food Canada and the National Research Council. BOREAS contributes to each country's Global Change Research Program.

- end -

Note to Editors: An image taken by the Space Radar Laboratory of the BOREAS ground site is available to news media from NASA's Jet Propulsion Laboratory, Pasadena, Calif., Phone: 818/354-5011. The image is available electronically to the general public over the Internet at the address JPLINFO.JPL.NASA.GOV.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Mark Hess
Headquarters, Washington, D.C.
(Phone: 202/358-1776)

For Release

April 28, 1994

RELEASE: 94-66

NASA ANNOUNCES SPACE FLIGHT PERSONNEL CHANGES

Associate Administrator for Space Flight Jeremiah Pearson today announced key personnel changes in the Office of Space Flight (OSF), NASA Headquarters, Washington, D.C.

Effective immediately, Tom Utsman, currently Deputy Associate Administrator (Space Shuttle), OSF, will return to the Kennedy Space Center (KSC), Fla., to become Special Assistant to the Associate Administrator, OSF. Bryan O'Connor, OSF Deputy Associate Administrator will replace Utsman and also serve as Space Shuttle Program Director.

Effective May 9, Richard Wisniewski, who retired from NASA in 1990 after a government career spanning 35 years, is returning to NASA to replace Brian O'Connor as Deputy Associate Administrator, OSF.

Pearson also announced that Michael Mann, Deputy Associate Administrator (Management), OSF, has been named Deputy Associate Administrator (Management) for NASA Headquarter's Office of Mission to Planet Earth. Wisniewski also will serve as Acting Deputy Associate Administrator (Management), OSF.

As Space Shuttle Program Director, O'Connor will assume responsibility for the management of the Space Shuttle Program. O'Connor, a former NASA astronaut, served as commander of the first Spacelab Life Sciences mission, STS-40, in June 1991, and as pilot on mission 61-B in November 1985. During the period following the Challenger accident, O'Connor served as Assistant to the Shuttle Program Manager from March 1986 until February 1988.

O'Connor helped guide the effort that led to the resumption of Shuttle flights in September 1988. He is a distinguished Marine Corps pilot and graduate of the U.S. Navy Test Pilot School. He also is a graduate of the U.S. Naval Academy and earned a Masters of Science degree in Aeronautical Systems from the University of West Florida. O'Connor served as an astronaut from 1980 to 1991.

-more-

Utsman will be returning to KSC where he held a number of key positions, including Deputy Director from August 1985 until his assignment to NASA Headquarters in January 1990.

Utsman's first assignment at NASA Headquarters was Deputy Associate Administrator for Space Flight (Management) which he held for approximately 6 months prior to being named Deputy Associate Administrator in June 1990. He was named Space Shuttle Director in June 1992.

Utsman began his career in 1963 as a facilities design engineer for the Apollo Program. He holds a Bachelor of Science degree in Mechanical Engineering from the University of Michigan and a Masters degree in Management from Florida State University.

Wisniewski currently is Director, Program Analysis Group, General Research Corp., Vienna, Va. His last position at NASA was as the Deputy Associate Administrator (Institutions), OSF. The Deputy Associate Administrator, OSF, is responsible for resources, policy and plans, human resources and management of the four Space Flight installations, Kennedy Space Center, Fla.; Johnson Space Center, Houston; Marshall Space Flight Center, Huntsville, Ala., and Stennis Space Center, Miss.

Wisniewski began his career at the Lewis Research Center, Cleveland, Ohio, as an aeronautical research engineer. He was staff scientist for the OSF during the Apollo Program, Director of Advanced Concepts in the former Office of Aeronautics and Space Technology and Deputy Associate Administrator for the Center Operations in the former Office of Management, Washington, D.C. Wisniewski has a Bachelor of Science degree in physics from John Carroll University.

Mann was named Deputy Associate Administrate (Management), OSF, in July 1993. Prior to that, he served as Director, Resource Management, responsible for managing the OSF's budget. Before joining the OSF, he spent 9 years in NASA's Comptrollers Office in a variety of cost analysis and resources management positions including Deputy Director, Resources Analysis Division. In that position Mann had oversight responsibility for all NASA programs and played a key role in the development of NASA program control and financial management policies.

A U.S. Army veteran, Mann is a graduate of the Virginia Polytechnic Institute with an MBA in Operations Research.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Drucella Andersen
Headquarters, Washington, D.C.
(Phone: 202/358-4733)

Michael Mewhinney
Ames Research Center, Mountain View, Calif.
(Phone: 415/604-9000)

For Release
May 2, 1994

RELEASE: C94-k

NASA AWARDS CONTRACT FOR PARALLEL COMPUTING TESTBED

NASA today selected a research consortium headed by IBM to carry out research and test computer systems for a new national aeroscience research program using parallel computer technology.

The selection marks the first time NASA is using a cooperative agreement as a joint venture to conduct computer research and tests. "We're pleased to be working with the consortium," said Dr. Wesley L. Harris, NASA's Associate Administrator for Aeronautics, who selected the consortium for the cooperative agreement. "IBM is known around the world for its leadership in advanced computing technology."

The consortium will receive $22.4 million to conduct the research under NASA's High Performance Computing and Communications (HPCC) program. The consortium members are International Business Machines Corp. (IBM), Somers, N.Y.; Boeing Computer Services Co., Seattle; Rensselaer Polytechnic Institute, Troy, N. Y.; Lockheed Missiles and Space Co., Inc., Palo Alto, Calif.; Centric Engineering Inc., Palo Alto; Intelligent Aerodynamics Inc., Princeton, N.J.; and Rice University, Houston.

NASA's Ames Research Center, Mountain View, Calif., will be the principal computational site for the new program. Ames is NASA's lead center for supercomputer research, using supercomputers that are the most advanced in the aerospace field. NASA's Langley Research Center, Hampton, Va., also will participate in this research.

-more-

Project scientists will use the new IBM SP-2 parallel computer systems. IBM will provide three computers for the cooperative research with NASA's Computational Aerosciences Project, which is part of NASA's HPCC program. The large system will be located at the Ames Numerical Aerodynamic Simulation (NAS) facility. Small development computers also will be located at Langley and at Rice University.

"Parallel computers are a new approach to scientific computing," said Ames research scientist David Bailey. "A parallel computer system links hundreds or even thousands of processors to form a supercomputer to solve complex equations. The IBM SP-2 has 160 processors and will outperform the conventional mainframe computers we now have at a significantly lower cost."

"One thrust of this effort is to learn about parallel computers. Our goal is to have a 'highly parallel computer system' serve as our production supercomputer here at NAS," he added.

NAS is a national supercomputer facility linked to more than 1,200 industry, university, government and NASA scientists by its national computer network called AEROnet.

"This is a good opportunity for an early evaluation of high performance parallel computers," said Marisa Chancellor, deputy chief of the Numerical Aerodynamic Simulation Systems Division at Ames. "We are looking forward to getting started on this project."

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Ed Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1778)

Kyle Herring
Johnson Space Center, Houston
(Phone: 713/483-5111)

For Release
May 2, 1994

RELEASE: 94-67

AVAILABILITY OF SHUTTLE CREWS CHANGES FOR POST-FLIGHT INTERVIEWS

In an effort to improve the timeliness of information released to the news media about Space Shuttle missions, NASA has announced that the six astronauts who have recently returned from Endeavour's mission will be available for interviews as time permits during their debriefing schedule.

Typically, astronauts have been available for interviews following completion of mission debriefings, which usually last about two weeks. This earlier one-on-one interview availability replaces the standard post-flight press conference.

During the STS-59 mission, Commander Sid Gutierrez, Pilot Kevin Chilton and Mission Specialists Jay Apt, Rich Clifford, Linda Godwin and Tom Jones worked around the clock on two shifts using sensitive radar equipment to help understand global changes in the environment.

Endeavour's flight was the first flight of the Space Radar Laboratory. During the 11-day mission, almost 25 percent of the Earth's surface was mapped. A second flight of the equipment is scheduled for August.

The crew will show video highlights and slides from the flight during a presentation to employees at the Johnson Space Center, Houston, May 10, beginning at 4:30 p.m. EDT. The presentation will be preceded by the award of Space Flight Medals to the astronauts.

The briefing will be carried on NASA television. News media are invited to attend but questions are limited to employees only. NASA television is carried on Spacenet 2, transponder 5, channel 9, located at 69 degrees West longitude, with a frequency of 3880 MHz.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

For Release

Ed Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1778)

May 3, 1994

Ernie J. Shannon
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/544-0034)

RELEASE: C94-1

NASA AWARDS BILLION DOLLAR CONTRACT TO CSC

NASA's Marshall Space Flight Center (MSFC), Huntsville, Ala., has awarded the Computer Sciences Corp. (CSC), Arlington, Va., a contract to provide Program Information Systems Mission Services (PrISMS).

The PrISMS acquisition will provide for all MSFC Information Services, Program Support Communications Services and some agency-wide Information Management Services assigned to Marshall.

The cost-plus-award-fee contract is expected to be valued at approximately $1.045 billion over eight years, a two-year base period and six one-year priced options.

Marshall negotiated serially with Harris Space Systems Corp., Rockledge, Va., Boeing Computer Support Services, Huntsville, Ala., and CSC before awarding the contract.

The mission services of this acquisition include information systems support for programs and projects for which MSFC is responsible. These services are described under three general categories.

MSFC Information Services include applications software, computer systems, networks, telephones, data reduction, audio/video and other defined services.

- more -

Program Support Communication Services provide networking among NASA installations, contractor sites and various international locations. These networks services include teleconferencing, messaging and networking, data transmission services, international telecommunications and agency FTS 2000 integration.

Agency-wide services include development and maintenance of agency-wide applications and systems delegated to MSFC, as well as general support to the Automated Information Management Program Office at NASA Headquarters.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Barbara Selby
Headquarters, Washington, D.C.
(Phone: 202/358-1983)

Allison Ballew
Langley Research Center, Hampton, Va.
(Phone: 804/864-8150)

For Release

May 4, 1994

RELEASE: C94-m

EG&G LANGLEY, INC., SELECTED FOR CONTRACT NEGOTIATIONS

NASA's Langley Research Center, Hampton, Va., has selected EG&G Langley, Inc., Hampton, Va., for negotiation of a contract to provide maintenance, construction and engineering support for the center.

The five-year, cost-plus-award-fee contract is estimated at $130 million, including options. The contract will be effective June 1, 1994.

The company will provide maintenance and support for piping systems, electrical systems and equipment, mechanical systems and machinery, and the NASA Langley utility control system. In addition, EG&G Langley will provide services for various construction activities, engineering designs and evaluations, calibration and testing and ultrasonic cleaning.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Mark Hess/Ed Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1778)

For Release
May 3, 1994
4:00 p.m. EDT

Dom Amatore
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/544-0034)

RELEASE: 94-68

YELLOW CREEK FACILITIES TO PERFORM SHUTTLE NOZZLE WORK

NASA Administrator Daniel S. Goldin today announced agency plans to proceed with an effort to use the nearly-completed facilities at Yellow Creek in Iuka, Miss., originally designed for use with the proposed Advanced Solid Rocket Motor (ASRM), for use with the manufacture of nozzles for the current Space Shuttle Redesigned Solid Rocket Motor (RSRM) program.

"Since the idea of utilizing the Yellow Creek facility for RSRM nozzle work was announced last December, NASA and the Thiokol Corporation have worked closely to complete a detailed implementation plan. After reviewing their efforts, I have directed the Office of Space Flight, through the Marshall Space Flight Center, to proceed with the implementation of this activity," Goldin said.

The transition effort for nozzle work at Yellow Creek will begin immediately. It is expected to take approximately 2 1/2 years to fully qualify the facility and the nozzles that are manufactured at the site.

Thiokol plans to move all of their nozzle operations to the Yellow Creek facility. They will assume the capital investment costs to complete the facility transition effort which has been estimated at approximately $88 million. Thiokol also will seek new government and private sector customers to maximize the potential use of the facility.

Thiokol will establish a nozzle "center of excellence" at Yellow Creek and invest in nozzle research. This effort will be of benefit to NASA and the American launch industry as a whole, once enhancements are perfected. For the Shuttle Program, the relocation of the RSRM nozzle manufacturing from Utah to Yellow Creek provides the opportunity to upgrade and consolidate the manufacturing process under one roof and increase the use of automation.

-more-

Goldin explained that "because the federal government has invested a significant amount of taxpayer money in the construction of state-of-the-art facilities at Yellow Creek, NASA is committed to obtaining the maximum possible return on this investment while at the same time attempting to mitigate the economic impact on the Iuka region resulting from last year's ASRM termination."

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

For Release

May 4, 1994

Barbara Selby
Headquarters, Washington, D.C.
(Phone: 202/358-1983)

Michael Mewhinney
Ames Research Center, Mountain View, Calif.
(Phone: 415/604-9000)

RELEASE: 94-69

ELECTRONIC CHART WILL AID AERIAL FIREFIGHTERS

NASA scientists are designing an electronic chart to make flying safer for aerial firefighters who often fly in potentially dangerous conditions above forest fires.

The Electronic Chart Display (ECD), being developed at NASA's Ames Research Center, Mountain View, Calif., shows pilots an area's terrain and obstacles on a computer screen.

"Whether alone or with a glass cockpit, the electronic map provides a unique navigational capability and reduces the potential for human error," said Dr. James P. Jenkins, Program Manager for Human Systems Technology in NASA's Office of Aeronautics, Washington, D.C.

Several accidents and mid-air near collisions involving aerial firefighters have occurred in recent years. Scientists predict the ECD will increase safety by reducing the need for verbal communication between firefighters and by showing pilots terrain to avoid as well as the location of other nearby aircraft. It also will help aerial commanders direct the assault on fires.

"The electronic chart can replace paper charts, pens and rulers and improve the navigational skills of pilots," said Vernol Battiste, Ames principal investigator and a former air traffic controller. "This system improves the navigational capabilities of anyone flying an airplane."

The project has three research goals. The first is to develop a flight environment structure applicable to any forest fire area. This environment will resemble a control zone similar to those used by air traffic controllers to regulate

-more-

an airport's takeoffs and landing. The control zone drawn around the fire will show the pilots how to enter and leave the area safely.

Another objective is to develop a common language including geographic, aviation and fire related terms. To accomplish this, scientists will study the speech patterns of aerial firefighters during forest fires.

The third goal is to integrate and display the flight environment information to the pilot.

"To pull all this together, we need a medium to display this information," Battiste said. Scientists are developing a software program jointly with ASINC Inc., Tustin, Calif., and the Bureau of Land Management's Nevada State Office.

The electronic chart will use the Global Positioning System (GPS) to determine an aircraft's position and then show it on a map of the area. The GPS consists of 24 satellites orbiting the Earth. Each GPS satellite broadcasts time based on an atomic clock. Pilots use the intervals between satellite transmissions to determine their aircraft's location.

Ames project engineer Michael Downs developed the ECD system on a personal computer. The ECD has a 9-inch (22.86 centimeters) color monitor and stores the display's digital map images in its memory system.

The ECD has many other potential uses. "The electronic chart display is useful in any environment where people have to navigate," Battiste said. "In an automobile, it could align you with the road and display the route from your departure to your destination on the screen," he said.

"This type of system will revolutionize travel," Battiste said. "With an electronic chart display, you won't need a paper map in your car. This is going to change the way we drive and the way we fly."

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Terri Sindelar
Headquarters, Washington, D.C.
(Phone: 202/358-1977)

For Release

May 4, 1994

RELEASE: 94-70

NASA SSIP WINNERS HONORED IN WASHINGTON, D.C.

Twenty-four students from public and private schools across the U.S. have won national recognition in NASA's 14th annual Space Science Student Involvement Program (SSIP) competition. The students will be honored along with their teachers at the National Space Symposium, May 7-11, at the Hotel Washington, 515 15th St., N.W., Washington, D.C.

The competition, co-sponsored by NASA and the National Science Teachers Association, is an interdisciplinary program designed to address the need for greater literacy in the areas of science, critical and creative thinking, mathematics and technology. Over 4,000 students in elementary, junior high, and high school competed in five competition categories using their skills in mathematics, science, technology, art and creative writing.

The National Space Science Symposium brings together the 24 national SSIP winners and their teachers for the purpose of recognizing their academic achievement in an environment designed to further challenge their talents. The trip to the symposium includes formal presentations by the students of their entries.

In addition to their recognition in Washington, the students will have the opportunity to intern at a NASA field center for a week during the summer and will receive a Space Camp scholarship. Winners of the Interplanetary Art competition will have their artwork displayed in museums, schools and other public sites throughout the year.

Schedule

On Monday, May 9, at 1:30 p.m., eight national high school student winners will present proposals for a Mars Science Experiment Project to a panel of scientists. The students will compete for a trip with their teacher/advisor to a NASA Center for an educational learning experience.

- more -

On Tuesday, May 10, students will tour the Capitol and meet their members of Congress.

At 6:30 p.m. on Tuesday, the students and their teachers will be honored at a banquet at the Hotel Washington. The banquet speaker will be Dr. Mary Cleave, a former astronaut who is currently the Project Manager of SeaWiFs at NASA's Goddard Space Flight Center, Greenbelt, Md.

Competitions and Winners

Mars Science Expedition

Students in grades 9 to 12 planned and developed a trip to Mars and proposed an experiment to be conducted along the way. Students were required to follow the guidelines of the scientific method when designing the study. The following students will compete on May 9, at 1:30 p.m.:

- Raffi Krikorian, Clarkstown H.S. South, West Nyack, N.Y.
- James Schaefer, Glenbrook North H.S., Northbrook, Ill.
- Stephen Whyte, Lake Braddock Secondary School, Burke, Va.
- Ryan Hall, Trinity Prep School, Winter Park, Fla.
- Tim Brister, Springtown H.S., Springtown, Texas
- Anabelle Duldulao, Waipahu H. S., Waipahu, Hawaii
- Julia Scozzafava, Laramie Senior H.S., Laramie, Wyo.
- Matthew Horner, Montgomery Blair H.S., Silver Spring, Md.

The judges for the presentations will be Alphonso V. Diaz, Deputy Associate Administrator for NASA's Office of Space Science; Elizabeth E. Beyer, Manager of Operational Programs, NASA's Solar System Exploration Division; and Dr. Michael A. Meyer of NASA's Solar System Division.

Interplanetary Art Competition

Students in grades 3 to 12 expressed their talents in science and art by creating a two-dimensional illustration depicting a scene from interplanetary space and writing an essay describing the picture. The art work will be displayed for public viewing.

- Katie Bilharz, Mott Road Elementary School, Fayetteville, N.Y.
- Josh Small, Creston Jr. H.S., Indianapolis, Ind.
- Donna Winder, Wilmington Christian School, Hockessin, Del.

Future Aircraft/Spacecraft Design Competition

Students in grades 3 to 5 worked in teams to design a futuristic aircraft or spacecraft. The students created three illustrations and wrote an essay describing the spacecraft.

- Chelsea Stertz, Sara Habib, Amy Nyberg and Todd Peterson, Corbett Elementary School, Tucson, Arizona.

Mission To Planet Earth

Students in grades 6 to 8, worked in three person teams to create an interdisciplinary project using satellites to study the effects of human activity on the Earth's ecosystem. They use research methods and an understanding of technology to search for solutions to society's ecological problems.

o Eli Alper, Michael Kiser and William Trimble, Trinity Prep, Winter Park, Fla.

Aerospace Internship Competitions

Students in grades 9 to 12 competed for a one-week internship with their teacher/advisor at a NASA facility. Students were chosen on the basis of a written proposal of an experiment that could theoretically be performed at one of the facilities such as NASA's supercomputer, drop tube, wind tunnel, Space Station or Spacelab.

Supercomputer Internship

o Daniel Gould, Montgomery Blair H.S., Silver Spring, Md., will intern at NASA Ames Research Center, Moffett Field, Calif., with scientists and engineers working on the Cray Computer.

Space Station Internship

o Wendy Kaneshiro, Waipahu H.S., Waipahu, Hawaii, will intern at the NASA Johnson Space Center, Houston, with scientists and engineers working on the Space Station.

Wind Tunnel Internship

o Thomas Sapienza, Shoreham-Wading River H.S., Shoreham, N.Y., will intern at NASA Langley Research Center, Hampton, Va., with scientists and engineers conducting research in aerodynamics using wind tunnels.

Drop Tube Internship

o Garrett Bach, Centennial H.S., Meridian, Idaho, will intern at NASA Lewis Research Center, Cleveland, Ohio, with scientists performing microgravity experiments in a drop tube.

SpaceLab Internship

o Athene Hodges, Montgomery Blair H.S., Silver Spring, Md., will intern at NASA's Marshal Space Flight Center, Huntsville, Ala., conducting experiments with scientists and engineers in the pressurized Spacelab module.

Space Astronomy Internship

o Christopher Del Rosso, Comsewoque H.S., Port Jefferson Station, N.Y., will intern at NASA's Goddard Space Flight Center, Greenbelt, Md., and work with astronomers conducting research in observational and theoretical astronomy and solar physics.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Sarah Keegan
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

Kyle Herring
Johnson Space Center, Houston, Texas
(Phone: 713/483-5111)

For Release
May 5, 1994

RELEASE: 94-71

HUBBLE TEAM TO RECEIVE COLLIER TROPHY

The NASA Hubble Space Telescope Recovery Team will receive the 1993 Robert J. Collier Trophy from the National Aeronautic Association on May 6, 1994. The citation will honor the team "for outstanding leadership, intrepidity, and the renewal of public faith in America's space program by the successful orbital recovery and repair of the Hubble Space Telescope."

NASA Administrator Daniel S. Goldin said, "This 11-member team represents the thousands of men and women across the country and around the world who played a part in the Hubble Space Telescope first servicing mission. Their accomplishments demonstrate the value of global teamwork, comprehensive training and extensive rehearsal in preparing for and executing critical missions."

The HST Recovery Team is composed of Joseph Rothenberg, previously Associate Director of Flight Projects, Goddard Space Flight Center, Greenbelt, Md.; Randy Brinkley, STS-61 Mission Director, Johnson Space Center (JSC), Houston; James M. "Milt" Heflin, Jr., STS-61 Lead Flight Director, JSC; Brewster H. Shaw, Jr., Director, Space Shuttle Operations, NASA Headquarters, Washington, D.C.; and the members of the STS-61 flight crew, commander Richard O. Covey, pilot Kenneth D. Bowersox, and mission specialists Tom Akers, Jeffrey A. Hoffman, F. Story Musgrave, Claude Nicollier (European Space Agency), and Kathryn C. Thornton.

The Robert J. Collier Trophy is widely considered the most prestigious aeronautical award in America.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Sonja A. Maclin
Headquarters, Washington, D.C.
(Phone: 202/358-1600)

For Release

May 6, 1994

EDITORS NOTE: N94-31

NASA TV TO PROVIDE COVERAGE OF ANNULAR ECLIPSE

NASA TV will provide television coverage of the annular eclipse of the Sun on May 10, 1994, beginning at 11:30 a.m. EDT.

A special edition of the NASA TV news show, *NASA Today*, will feature an interview with NASA Astrophysicist Fred Espenak from NASA's Goddard Space Flight Center (GSFC), Greenbelt, Md. Following the *NASA Today* news show, a pre-recorded episode of *The Night Sky* will air at 11:35 a.m. EDT, advising viewers how and where to view the eclipse safely and effectively.

NASA's Tracking and Data Relay Satellite ground terminal in White Sands, N.M., will air a live picture of the Sun undergoing eclipse on NASA TV at 11:56 a.m. EDT. The eclipse will be in a total annular state around 12:06 p.m. EDT, lasting approximately four minutes.

A live one-hour edition of *The Night Sky* will broadcast from Wauseon, Ohio (near Toledo) at 12:30 p.m. EDT. The educational program will show, weather permitting, views of the eclipse, both live and on tape, from the Kennedy Space Center, Fla.; the Johnson Space Center, Houston; the NASA Facility at White Sands, N.M.; and the Jet Propulsion Laboratory, Pasadena, Calif. In addition, viewers will see the eclipse live from Wauseon from 1:15 p.m. to 1:30 p.m. EDT.

NASA TV is carried on Spacenet 2, transponder 5 (channel 9), 69 degrees West, transponder frequency is 3880 MHz, audio subcarrier is 6.8 MHz, polarization is horizontal.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

For Release

Donald L. Savage
Headquarters, Washingon, D.C.
(Phone: 202/358-1547)

May 6, 1994

Lynn Simarski
National Science Foundation, Arlington, Va.
(Phone: 703/306-1070)

NOTE TO EDITORS: N94-32

COMET IMPACT '94 MEDIA BRIEFING SET FOR MAY 18

The latest image of Comet Shoemaker-Levy-9, the "string of pearls comet" which will collide with Jupiter this summer, obtained from the Hubble Space Telescope will be released at a media briefing scheduled for 1 p.m. EDT, Wed., May 18, in the NASA Headquarters auditorium, 300 E St., S.W., Washington, D.C.

The briefing also will feature a science panel discussion of the impending impact with Jupiter and the worldwide NASA/National Science Foundation (NSF) program which will observe and study the event.

The panelists will be Dr. Eugene Shoemaker, U. S. Geological Survey, Flagstaff, Ariz., co-discoverer of the comet; Dr. Heidi Hammel, Massachusetts Institute of Technology, Cambridge; Dr. Lucy McFadden, University of Maryland, College Park; and Dr. Harold Weaver and Dr. Melissa McGrath, Space Telescope Science Institute, Baltimore, Md.

Following the panel discussion will be a brief presentation on the plans for NASA/NSF Comet Impact news media operations, which includes daily coverage on NASA television during the week of the impacts (July 16-22). Press kits containing information, images and fact sheets will be available for news media representatives. Also available will be a videotape of animation depicting fragments of the comet colliding with Jupiter.

The briefing will be carried live on NASA Television, on Spacenet 2, transponder 5, channel 9, 69 degrees West longitude, transponder frequency is 3880 MHz, audio subcarrier is 6.8 MHz, polarization is horizontal. There will be two-way question-and-answer capability for reporters covering the briefing from NASA centers.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

For Release
May 6, 1994

Don Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Fred A. Brown
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-7277)

Keith Henry
Langley Research Center, Hampton, Va.
(Phone: 804/864-6124)

RELEASE: 94-72

SCOUT LAUNCH VEHICLE TO RETIRE AFTER 34 YEARS OF SERVICE

NASA has scheduled the 118th and final flight of the Solid Controlled Orbital Utility Test (SCOUT) launch vehicle for Friday, May 6, from the Western Test Range, Vandenberg Air Force Base, Lompoc, Calif. The 10-minute launch window opens at 10:45 p.m. EDT.

SCOUT has been a reliable rocket for nearly 34 years, flying its first mission on July 1, 1960, and becoming one of NASA's most successful launch vehicles. SCOUT's reliability for the last 26 years has been 98.3 percent and, since 1976, its launch success rate has been 100 percent. According to project officials, this reliability can be traced to its use of standardized launch and manufacturing procedures and the incorporation of off-the-shelf technology.

Although it is the smallest NASA launch vehicle capable of orbiting satellites, SCOUT has been a real workhorse for the space agency. Due to its extensive contributions to the space program and the limited publicity it has received, SCOUT has been called, "the unsung hero of space."

The SCOUT program was managed from 1958 through Dec. 1990 by NASA's Langley Research Center, Hampton, Va. Program management was transferred to NASA's Goddard Space Flight Center, Greenbelt, Md., in Jan. 1991.

-more-

The last SCOUT will launch a Miniature Sensor Technology Integration (MSTI) satellite. The satellite, designated MSTI-2, will conduct tracking and Earth-observation experiments. Designed and built by Phillips Laboratory at Edwards Air Force Base, Calif., the MSTI program is in support of the Ballistic Missile Defense Organization's Theater Missile Defense Directive. A SCOUT launch vehicle launched the first MSTI satellite in Nov. 1992.

This launch vehicle had its beginnings as early as 1957. The U. S. needed a relatively inexpensive, quickly produced rocket to launch small research experiments, and Langley engineers were asked to design it. Their goal was to provide a launch vehicle capable of performing a variety of probe, re-entry and orbital missions with minimum preparation time.

The conception was complete in 1958, and Chance Vought Aircraft (now Loral Vought Systems) was placed under contract in March 1959 to build SCOUT vehicles. This was the beginning of a government/contractor relationship which has lasted more than 35 years.

SCOUT was America's first solid-fuel launch vehicle capable of orbiting a satellite. The standard SCOUT launch vehicle is a solid-propellant, four-stage booster system, approximately 75 feet (23 meters) long with a launch weight of 47,398 pounds (21,500 kilograms).

Unlike most of NASA's larger expendable rockets, the SCOUT is assembled and the payload is integrated and checked-out in the horizontal position prior to launch. SCOUT's first-stage motor was based on an earlier version of the Navy's Polaris missile motor. The second-stage motor was developed from the Army's Sergeant surface-to-surface missile, and the third- and fourth-stage motors were adapted by Langley from the Navy's Vanguard missile.

The first SCOUT was launched from Goddard's Wallops Flight Facility, Wallops Island, Va., on July 1, 1960. The rocket carried a 193-pound (88-kilogram) payload as a probe test. On February 16, 1961, Scout became the first solid-fuel rocket to place a payload into orbit. The vehicle carried a 96-pound (44-kilogram) NASA atmospheric physics payload into orbit without incident.

Two launch sites were added in subsequent years. One, at the Western Test Range at Vandenberg Air Force Base, was added in 1962. Another was built on Italy's unique sea-based San Marco platform off the east coast of Kenya, Africa, the site of nine successful equatorial missions since 1967.

SCOUT capability grew dramatically over the years. Originally able to place a 131-pound (59-kilogram) payload in a nominal 345-mile (552-kilometer) circular orbit, SCOUT performance was improved, increasing its capability to put a 458-pound (208-kilogram) payload into the same orbit. The heaviest satellite ever placed in orbit by SCOUT was an Italian payload that weighed more than 600 pounds (270 kilograms) and was launched out of Africa. SCOUT increased its load-carrying capability 350 percent over that of the original vehicle with little increase in the size of its stages.

The SCOUT program has made possible important contributions to knowledge of space, not only for the U. S. but also for a number of foreign nations, including Italy, Great Britain, Germany, France, the Netherlands and the multi-national European Space Agency. These contributions have been in navigation, astronomy, geodesy, meteoroid environment, re-entry materials, biology, spacecraft technology and applications.

To commemorate SCOUT's contributions to the American space program, there is a SCOUT rocket on display in the Smithsonian Institution's National Air and Space Museum, Washington, D.C.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Ed Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1778)

James Hartsfield
Johnson Space Center, Houston
(Phone: 713/483-5111)

For Release
May 9, 1994

RELEASE: C94-n

CONTRACT SIGNED FOR 'GLASS COCKPIT' SHUTTLE UPGRADE

NASA has signed a contract modification with Rockwell International Space Systems Division, Downey, Calif. The contract, valued at $80.58 million, will provide for the production of the Multifunction Electronic Display Subsystem (MEDS) to be installed in each of the four Space Shuttle orbiters.

The MEDS consists of color active, matrix liquid crystal displays that will replace some of the current electromechanical flight instruments and meters in the shuttle cockpit. Installation and first flight of the equipment is planned for 1998. Similiar technology, commonly called "glass cockpit" instrumentation, is already in use in commercial aircraft. The MEDS will be among the first United States-manufactured liquid crystal flat panel displays to be used in aerospace.

The displays will provide state-of-the-art, multifunction interfaces between the flight crew and the shuttle orbiter's flight control computers. They will provide computer-generated information on altitude, airspeed, heading, vehicle attitude and other aspects of flight control. They also will replace the current cathode ray tube displays in the shuttle cockpit.

The contract covers the production of MEDS equipment to be installed in all shuttle orbiter trainers and avionics laboratories at the Johnson Space Center, Houston. The contract also includes fabrication, assembly, acceptance testing, packaging and delivery of the MEDS hardware.

The majority of the prime contract effort will be performed at the Rockwell facility in Downey. The majority of the subcontract effort will be performed at the Honeywell, Inc., facility in Phoenix, Az.

- end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Brian Dunbar
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release

May 9, 1994

NOTE TO EDITORS: N94-33

NASA ADMINISTRATOR TO PARTICIPATE IN WHITE HOUSE BRIEFING

NASA Administrator Daniel S. Goldin will join Dr. John H. Gibbons, Assistant to the President for Science and Technology Policy and representatives from the departments of Defense and Commerce in a White House briefing to address the convergence of U.S. weather-satellite systems and the Landsat Program. The briefing will take place on Tues., May 10, at 11:30 a.m. EDT, in room 450 of the Old Executive Office Building.

Media representatives who wish to attend that do not have White House press credentials should contact Keith Boykin in the White House Media Affairs Office (202/456-7150) before 9 a.m. Media representatives should report to the White House Press Office (lower level) before 11:10 a.m. for escort to the briefing.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Drucella Andersen (Aeronautics)
Headquarters, Washington, D.C.
(Phone: 202/358-4733)

Jim Cast (Space)
Headquarters, Washington, D.C.
(Phone: 202/358-1779)

For Release
May 9, 1994

RELEASE: 94-73

NATIONAL FACILITIES INVENTORIED, NEEDS ESTABLISHED

A National Facilities Study released today indicates the need for two new wind tunnels and provides 70 recommendations affecting aeronautics and space facilities nationwide.

Conducted by representatives from NASA and the Departments of Commerce, Defense, Energy and Transportation, the study identifies federal government and industry facility shortfalls and recommends new facility requirements, consolidation opportunities and closures.

"Shaping our national facilities to best meet our country's needs should be a continuous process and this study is the first step," said NASA Administrator Daniel S. Goldin. "We should capitalize on this to improve our plans for using these national resources."

The recommendations endorsed by the National Facilities Study Team have been submitted for review to the participating agencies. Cost savings, if implemented, are estimated at $114 million annually. Some of these savings already are reflected in agency budget submissions.

One finding of the study is that aerospace facility inventories were incomplete and outdated. The study also provides the first comprehensive, computerized database of U.S. aeronautics and space facilities. Potentially, this can be used to evaluate existing facilities before construction of a new facility is considered. The inventory data now include facility characteristics, performance features, an estimate of usage and contact points for additional information. The computerized database contains over 2,800 facilities and is still growing as additional government and industrial organizations provide information.

-more-

Cited as the most critical among the new needs is the development of two wind tunnels for testing future commercial jet transports. These tunnels -- one subsonic and one transonic -- would provide a combination of flight condition simulation and testing efficiency unmatched in the world. The study recommends the tunnels should be operating by the year 2002 to provide the U.S. with the competitive edge needed for the next round of wide-body commercial transport competition.

Additionally, the study indicates that a new supersonic facility should not be constructed at this time. However, an investment to bring existing civil and defense facilities up to the productivity standards needed for commercial product development is recommended. The study also calls for a research plan on hypersonic facilities to be conducted by NASA, DoD and industry. Forty-four major government wind tunnels were reviewed for consolidation and closure.

A future mission and requirements model was developed as a key tool for assessing future aerospace facility requirements. A projection of future space mission requirements embraces military and civilian government and commercial sectors to help determine what type of facilities will be needed. Projections were extended for 30 years because of the long lead time inherent in facility development.

The study began in November 1992, when Administrator Goldin initiated a comprehensive and long-term plan for future aerospace facilities, to be accomplished in partnership with other government agencies and industry. The National Facilities Study has been submitted to the National Performance Review being conducted by Vice President Albert Gore, Jr., in response to the following directive: "NASA should work aggressively with its interagency counterparts to complete a summary report to the administration, by June 1994, identifying federal aerospace facility shortfalls, new facility requirements, consolidation opportunities and recommendations for closing."

-end-

NOTE TO EDITORS: To obtain a copy of the National Facilities Study Summary Report, a list of wind tunnels recommended for closure and the status of facility consolidations, please FAX your request to the NASA Headquarters Newsroom at 202/358-4210 or 4335. Copies of this information also are available at all NASA Centers nationwide.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

Barbara E. Selby
Headquarters, Washington, D.C.
(Phone: 202/358-1983)

Lori J. Rachul
Lewis Research Center, Cleveland, Ohio
(Phone: 216/433-8806)

For Release

May 10, 1994

RELEASE: C94-o

GILCREST ELECTRIC & SUPPLY AWARDED NASA CONTRACT

NASA's Lewis Research Center, Cleveland, Ohio, has awarded Gilcrest Electric and Supply Co., Elyria, Ohio, a contract to provide technical and fabrication services for the center's in-house research and development program.

The initial award is $2.5 million with the total estimated contract valued at $70 million. The cost-plus-award-fee contract will have a 30-day phase-in period, a basic period of two years and three one-year option periods for a total contract period not to exceed five years.

Services under the contract include assembling, installing, modifying and maintaining research test apparatus; preparing and processing of material samples, data taking, record keeping and other laboratory activities; and the machining, welding, wood modeling and sheet metal fabrication of research materials.

Award of this contract, under the small and disadvantaged business program, supports NASA's goal of awarding eight percent of its contracts to socially and economically disadvantaged groups.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

ISY

For Release

Barbara E. Selby
Headquarters, Washington, D.C.
(Phone: 202/358-1983)

May 10, 1994

Lori J. Rachul
Lewis Research Center, Cleveland, Ohio
(Phone: 216/433-8806)

RELEASE: C94-p

NASA SELECTS R&R INTERNATIONAL FOR SUPPORT CONTRACT

NASA's Lewis Research Center, Cleveland, Ohio, has selected R&R International, Akron, Ohio, for negotiations leading to the award of a contract for facilities operations and technical support services for the center's in-house research and development programs.

The cost-plus-fixed-fee contract, estimated at $21 million, will have a 15-day phase-in period, a basic period of two years and three one-year option periods. The contract is expected to take effect June 1, 1994.

The work, to be performed at Lewis, will include technical support in the operation and maintenance of research facilities support equipment; and installation, operation, modification and routine maintenance of research facilities.

Award of this contract, under the small and disadvantaged business program, supports NASA's goal of awarding eight percent of its contracts to socially and economically disadvantaged groups.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Drucella Andersen
Headquarters, Washington, D.C.
(Phone: 202/358-4733)

H. Keith Henry
Langley Research Center, Hampton, Va.
(Phone: 804/864-6120)

For Release
May 11, 1994

RELEASE: 94-74

TESTS SEEN AS STEP TOWARD QUIETER HELICOPTER BLADES

Converting a small area of a helicopter main rotor blade into a controllable flap may prove to be an important step toward greatly reducing the irritating noise known as "blade slap."

Tests conducted jointly by NASA, McDonnell Douglas and the U.S. Army indicate reductions in blade slap of four decibels in certain flight conditions using the concept. That translates to a reduction of 40 percent in the strength of the sound from blade slap. These results were obtained while simulating a helicopter flying through its own air turbulence during descent or landing, the time when blade slap is the loudest and when the helicopter is closest to people on the ground.

The McDonnell Douglas Helicopter Systems (MDHS) concept -- called active flap control -- was tested in a wind tunnel at NASA's Langley Research Center, Hampton, Va. The specially-built rotor model and test stand were designed and constructed by the MDHS facility at Mesa, Ariz. The Army Joint Research Program Office at Langley teamed with Langley because of an interest in exploring performance benefits using the flap control concept.

Costs for the $2 million project are approximately split between Langley and MDHS. For the tests, the model was fitted with flaps on the outer 20 percent of each blade trailing edge. The flaps were actively controlled in an attempt to limit the blade slap's sound. On either side of the model was an array of microphones that moved up and down the wind tunnel test section, mapping the noise "footprint" under the blades. To improve the quality of data gathered, the walls, ceiling and floor of the 14 x 22-foot Subsonic Tunnel were treated with special acoustic foam.

-more-

Flaps on the mode were actuated by a mechanical control system. MDHS Project Engineer, Seth Dawson, believes that hydraulic, electromechanical or smart material actuators could be used on a production helicopter.

Under some test conditions, blade slap noise levels were reduced by six decibels, equivalent to 50 percent reduction in sound strength.

However, the flap's effectiveness is highly dependent upon flight conditions and can cause noise increases if deployed at the wrong point and time, according to Ruth M. Martin, Rotorcraft Program Manager at Langley.

By varying test conditions, researchers were able to take data on use of the flaps for vibration control and for increased aerodynamic performance. These results are still being analyzed.

-end-

EDITORS NOTE: A photograph of the McDonnell Douglas rotor test model fitted with trailing edge flaps is available from the Langley Research Center. Contact: H. Keith Henry at 804/864-6120. Photo No. L-94-1851.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Jim Cast
Headquarters, Washington, D.C.
(Phone: 202/358-1779)

Kari Fluegel
Johnson Space Center, Houston
(Phone: 713/483-5111)

For Release
May 12, 1994

NOTE TO EDITORS: N94-34

PRESS CONFERENCES TO PREVIEW FUTURE SPACE OPERATIONS

NASA will provide "A Look at the Future" May 16 with a special series of press conferences that will include a preview of the upcoming joint U.S.-Russian space flights and the International Space Station, as well as discussions with the astronauts and cosmonauts currently training for the joint missions.

Astronauts Norm Thagard and Bonnie Dunbar and Cosmonauts Vladimir Dejourov, Gennadiy Strekalov, Anatoly Solovyev, Nikolai Budarin, Yury Onufrienko and Alexandr Poleshchuk will arrive at the Johnson Space Center, Houston, on Monday. The astronauts and cosmonauts will begin two weeks of life sciences training for experiments that will take place aboard the Russian Space Station Mir and aboard the Space Shuttle Atlantis during the STS-71 flight, currently scheduled for late May 1995. Onufrienko and Poleshchuk comprise the "third crew" and will be training as backup crew members.

While cooperative science efforts between the U. S. and Russia have been going on for years, the era of joint human space flight began in January 1994 when Cosmonaut Sergei Krikalev flew on Space Shuttle mission STS-60. The cooperation will continue with the flight of Cosmonaut Vladimir Titov on STS-63, an early 1995 mission which may include a Space Shuttle flying in formation with Mir. Thagard will become the first U.S. astronaut to fly on a Russian launch vehicle in March 1995 when he joins the Mir 18 crew for its three-month mission in space. Thagard and his Mir crewmates will return to Earth in May 1995 aboard the Space Shuttle Atlantis, which will dock with the Russian station during STS-71.

- more -

The ten Shuttle-Mir flights comprise Phase One of the International Space Station program. Phases Two and Three construct the orbiting research laboratory and begin initial operations. As the largest international scientific and technology development ever undertaken, the International Space Station will bring together resources from the U. S., Russia, member nations of the European Space Agency, Canada and Japan. Assembly of the station is expected to begin in December 1997 with human-tended operations beginning in June 1998 after the launch of the U.S. laboratory. Assembly will be complete in 2002.

The briefings, originating from the Johnson Space Center's Public Affairs briefing room (Bldg. 2, Room 135), will be broadcast on NASA TV with interactive question-and-answer sessions from all participating centers. NASA TV coverage may be accessed on Spacenet 2, Transponder 5, Channel 9, horizontal polarization, located at 69 degrees west longitude, 3880 megahertz.

AGENDA
All times listed are Eastern

Monday, May 16, 1994

10:00 a.m. Phase One: The Space Station Era Begins
Jim Nise, Phase One Manager, Space Station Program Office
Phil Engelauf, Lead STS-63 Flight Director
Gary Coen, Lead STS-71 Flight Director
Tom Sullivan, Shuttle/Mir Medical Project Mission Scientist
NASA Astronaut Ken Cameron, Manager, Star City Operations

11:30 a.m. Phase Two and Three: A Space Station Preview
Randy Brinkley, Manager, Space Station Program Office
Bill Shepherd, Deputy Manager, Space Station Program Office
Dan Tam, Business Manager, Space Station Program Office
Chuck Lloyd, Deputy Manager, Space Station Program Office

Science and Utilization Office

1:30 p.m. Mir 18 and 19 Astronaut/Cosmonaut Briefing
NASA Astronaut Norm Thagard
NASA Astronaut Bonnie Dunbar
Cosmonaut Vladimir Dejourov
Cosmonaut Gennadiy Strekalov
Cosmonaut Anatoly Solovyev
Cosmonaut Nikolai Budarin
(Translations will be provided)

3:00 p.m. Tour/Briefing of Johnson's New Consolidated Control Center
John Muratore, Chief, Control Center Systems Division
(Not televised -- Houston media only.)

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Donald L. Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Michael Finneran
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-5565)

For Release
May 12, 1994

RELEASE: 94-75

NASA TO STOP WORK ON POLAR SPACECRAFT

NASA Administrator Daniel S. Goldin today announced that the Agency will stop work on the Polar spacecraft and will continue with pre-launch activities on the Wind spacecraft. Work on Polar will resume only after the Wind spacecraft has been successfully operated on-orbit and a re-evaluation of the resources required for the completion of the GGS Program has been completed within the context of overall budget constraints.

In February, NASA announced the delay of the launches of both missions to examine potentially defective materials and processes used by the contractor to build components on the two spacecraft as well as to review the overall program. The launch date for the Wind spacecraft has not been firmly established pending completion of retest activities. The launch of the Wind spacecraft is expected to occur prior to the end of this year.

NASA is developing a set of critical program milestones that will be used to monitor contractor performance through the launch of the Wind spacecraft. The performance of the contractor in meeting these milestones will be closely monitored by NASA. If contractor performance on the Wind spacecraft is satisfactory and Polar is authorized to proceed, then critical program milestones will be developed to monitor the Polar spacecraft through the completion of its development and launch.

Additionally, NASA is in the process of totally restructuring the contractor award fee so that the contractor will receive no fee until on-orbit performance is satisfactory. The spacecraft contractor is Martin Marietta Astro-Space, East Windsor, N.J.

- more -

The Wind and Polar spacecraft constitute the U.S. contribution to the Global Geospace Science (GGS) Program, a part of the International Solar-Terrestrial Physics Program involving several spacecraft from the U.S., Europe and Japan in a study of the interaction of the solar wind and Earth's magnetic field.

The Wind and Polar projects are managed by NASA's Goddard Space Flight Center, Greenbelt, Md., for the Office of Space Science, Washington, D.C.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Don Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Steve Roy
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/544-6535)

For Release
May 13, 1994

Release: C94-q

NASA SELECTS BOEING TO PROVIDE SHUTTLE UPPER STAGE SYSTEM FOR THE ADVANCED X-RAY ASTROPHYSICS FACILITY

NASA's Marshall Space Flight Center, Huntsville, Ala. has selected Boeing Defense and Space Group, Missiles and Space Division, Seattle, Wash., for negotiations leading to award of a contract to provide the Shuttle Upper Stage system with related integration and launch support services for the space-based Advanced X-ray Astrophysics Facility (AXAF).

The cost-plus-award-fee contract is expected to be valued at approximately $49 million. The contract period of performance is anticipated to be from June 1994 through December 1998. The contract will include the necessary design, development and qualification, as well as manufacture, acceptance and delivery of the Shuttle Upper Stage for the AXAF mission. The contractor also will furnish related mission integration, launch, flight operations and post-mission evaluation services.

The Shuttle Upper Stage will provide the capability to place the AXAF spacecraft in a very high elliptical orbit to provide maximum science viewing opportunities.

Scheduled for launch in 1998, AXAF will be the third of NASA's series of orbiting Great Observatories. The AXAF telescope will capture high resolution images from X-ray sources and will produce "picture-like images" of X-ray data analogous to those made in visible light by optical telescopes.

NASA's Marshall Space Flight Center has management responsibility for the AXAF Shuttle Upper Stage system.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Sarah Keegan
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

For Release
May 17, 1994

NOTE TO EDITORS: N94-35

HUBBLE BRIEFING ON SUPERNOVAE: PAST AND PRESENT

Two new Hubble images of supernovae will be the subjects of a media briefing Thursday, May 19, 1994, at 11:00 am EDT in the NASA Headquarters auditorium, 300 E St., SW, Washington, D.C.

Presenting the images and their findings in a "Space Astronomy Update" will be Dr. Chris Burrows of the European Space Agency and the Space Telescope Science Institute, Baltimore, Md., and Dr. Robert Kirshner of Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass.

Host Dr. Stephen Maran, NASA's Goddard Space Flight Center, Greenbelt, Md., will be joined by Dr. Anne Kinney, astronomer, Space Telescope Science Institute, in a discussion of the significance of these findings.

Copies of the new Hubble images will be available at the briefing, and after the program there will be a clean video feed of the graphics used in the presentations.

This event will be carried live on NASA Television, Spacenet 2, 69 degrees west longitude, Transponder 5 (Channel 9), frequency 3880 MHz.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Drucella Andersen
Headquarters, Washington, D.C.
(Phone: 202/358-4733)

For Release
May 19, 1994

RELEASE: C94-r

NASA TAPS TEAMS FOR ADVANCED AERONAUTICAL RESEARCH

NASA today awarded contracts to 16 research teams for advanced aeronautics projects and studies in its largest-ever solicitation of breakthrough ideas from industry, universities and other government agencies.

Sponsored by NASA's Office of Aeronautics, under the Advanced Concepts for Aeronautics program, the contracts will develop aeronautical concepts that are technologically risky, but have a high potential payoff for U.S. industry. The contracts are designed to encourage creative solutions to aeronautics technology needs and to foster partnerships among researchers from industry, academia and NASA. By encouraging these partnerships, NASA is ensuring the rapid transfer of newly-developed technology throughout the U.S. aeronautics community.

"This was the first time NASA has solicited aeronautics research from industry on this scale, covering all disciplines, technologies and classes of aircraft," said program manager Dr. James P. Jenkins. "The response was phenomenal. The proposals ran the gamut from 'A' to 'V' -- aerodynamics to virtual reality."

The emerging fleets of aircraft and ground control systems that will be developed in the next 20 years will have their genesis in the 1990s. Therefore, this program is intended to enhance the competitiveness of the U.S. aeronautics companies and to ensure that they maintain and increase their lead in this important industry.

Six of the awards are for three-year product-oriented research projects, with an option for a fourth year. Under these contracts, the research teams will attack a specific technical challenge and define the benefits of its solution. The project also must include a demonstration of the advanced concept.

-more-

Ten of the contracts are for research analyses of advanced ideas. The selected teams are expected to produce a definitive analysis of an important aeronautical challenge and a suggested approach to solving it. Each study should be complete within three to seven months.

NASA received 160 proposals for research projects and analyses combined. The research is initially funded at $5 million per year for three years beginning in 1994.

-end-

EDITORS NOTE: A list of the contract awards is available to media representatives by faxing a request to the NASA Headquarters Newsroom at 202/358-4210 or -4335.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Brian Dunbar
Headquarters, Washington, D.C.
(Phone: 202/358-0873)

Michael Finneran
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/ 286-5565

For Release
May 19, 1994

RELEASE NO: C94-s

CORTEZ SELECTED TO NEGOTIATE $107 MILLION NASA CONTRACT

Cortez III Services Corp., of Albuquerque, N.M., has been selected to negotiate a five-year contract to provide comprehensive logistics services to NASA's Goddard Space Flight Center (GSFC), Greenbelt, Md., and its affiliated sites.

Cortez III proposed Anstec Inc., as its subcontractor for this procurement. The purpose of the contract is to support the mission responsibilities of the Logistics Management Division by providing logistics support services to GSFC at both Greenbelt and its Wallops Flight Facility (WFF) in Wallops Island, Va., and to NASA Headquarters in Washington, D.C.

Services include transportation; flight project planning and coordination support; travel for NASA's WFF; supply management; warehousing; property management and disposal; flight hardware storage; mail services for GSFC in Greenbelt; forms, records and directives management; and interior design/office space planning for systems modular furniture.

This follow-on requirement is a continuation of the effort currently performed by Ogden Logistics Services, which expires on June 30, 1994. The period of performance for the new contract is a one-year basic contract with one four-year priced option beginning July 1, 1994.

The level of effort equates to 206 work years (plus or minus 20 percent) for each contract year. The contract also will contain a provision for optional quantities to accommodate the increase in services associated with the Goddard East Campus, equipment, disposal and warehouse management at NASA Headquarters.

A separate one-month, fixed price phase-in contract will begin June 1, 1994. A cost-plus-award-fee, level-of-effort, task-assignment contract will be awarded. The total price proposed by Cortez III for the total five-year contract is $107 million.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Terri Sindelar
Headquarters, Washington, D.C.
(Phone: 202/358-1977)

For Release
May 19, 1994

NOTE TO EDITORS: N94-37

NASA AND MULTIPLE SCLEROSIS ASSOCIATION TO COLLABORATE

On Monday, May 23, at 9:30 a.m. EDT, NASA Administrator Daniel S. Goldin and the President of the Multiple Sclerosis Association of America (MSAA), John Hodson Sr., will sign an agreement to work cooperatively to advance the state of the art and application of cool suit technology for MS patients. The event, demonstrations and tour will take place at the National Rehabilitation Hospital (NRH), 102 Irving St., N.W., Washington, D.C.

Madlyn Rhue, actress, artist, native Washingtonian and MS patient, will demonstrate how NASA's cool suit technology, derived from the Apollo mission space suit, relieved her symptoms and improved her quality of life.

Jonathan M. Silver, Assistant Deputy Secretary of Commerce, and the White House coordinator for the President's new initiative to seek liaisons between the federal government and non-profit charities and foundations, will attend the event.

A donation of $10,000 will be presented to MSAA by Mr. William Schnirring, President of Technology Utilization Foundation. The gift is to be used to place cool suits with financially challenged MS patients.

At 10:30 a.m., Edward A. Eckenhoff, President and CEO of NRH, will lead a tour of the hospital's facilities where doctors conduct research on cool suit technology and other advanced technologies to help MS patients relieve disabling symptoms. MS patients undergoing treatment at NRH using the cool suit will discuss and evaluate their perceived improvement in walking, transfers, overall sense of well-being, and duration of the benefits of the cooling suit.

May is MSAA awareness month. More than 300,000 Americans are afflicted with this progressively disabling neurological disease that has no known cause, cure or prevention. The disease attacks the myelin, or insulation, of nerve cell fibers. The cool suit lowers the body temperature and some patients report that the suit helps alleviate symptoms of slurred speech, impaired vision, weakness and unsteady gait, unusual fatigue and improves cognitive abilities.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Sarah Keegan
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release

May 19, 1994
embargoed until 12:30 p.m. EDT

Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

Ray Villard
Space Telescope Science Institute, Baltimore, Md.
(Phone: 410/338-4514)

RELEASE : 94-76

HST OBSERVES THE SUPERNOVA IN THE WHIRLPOOL GALAXY

NASA's Hubble Space Telescope's (HST) Wide Field Planetary Camera 2 has returned valuable new images of the supernova 1994 I in the inner regions of the "Whirlpool Galaxy," M51, located 20 million light-years away in the constellation Canes Venatici.

A supernova is a violent stellar explosion that destroys a star, while ejecting the products of nuclear burning into the gas between stars. Debris from supernova explosions play a central role in increasing the heavy element abundance of galaxies. The material that makes up the Sun, the Earth, and our bodies was once inside stars that exploded long before the solar system formed about five billion years ago.

Supernova 1994 I was discovered by amateur astronomers on April 2, 1994, and has been the target of investigations by astronomers using ground-based optical and radio telescopes. At its brightest, around April 10, the supernova was about 100 million times brighter than the Sun.

Previous observations show that this is a very unusual supernova, called "Type Ic," for which very few examples have been studied carefully.

Following initial observations with the International Ultraviolet Explorer satellite, which demonstrated that the supernova could be detected in the ultraviolet, a preplanned series of observations was initiated by the international Supernova Intensive Survey (SINS) team, headed by Dr. Robert P. Kirshner of the Harvard-Smithsonian Center for Astrophysics.

-more-

The SINS group is using HST to study supernovae in the ultraviolet shortly after they are discovered, and at optical wavelengths as they become too faint to monitor from the ground. They hope to learn which stars explode as supernovae, what chemical elements are ejected by the eruption, and how to use these bright events as yardsticks for measuring the size of the universe.

For example, the Supernova 1987A, located in the nearby Large Magellanic Cloud, has been studied by the SINS team since the launch of the HST in 1990 and will continue to be a target of investigations.

The HST has the unique capability of being able to image and to measure the spectra of distant supernovae in ultraviolet light. As the M51 supernova ages, Hubble will see more deeply into the interior of the exploded star. This will allow astronomers to probe the chemical composition of the debris and to learn more about the type of star that exploded.

The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, Inc. (AURA) for NASA, under contract with the Goddard Space Flight Center, Greenbelt, Md. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency (ESA).

- end -

NOTE TO EDITORS: A black and white image will be available to news media in approximately a week from the Broadcast and Image Branch. To obtain an image, please FAX your request to the Branch at 202/358-4333. The photo number will be 94-H-160.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Sarah Keegan
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release
May 19, 1994
12:30 p.m. EDT

Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

Ray Villard
Space Telescope Science Institute, Baltimore, Md.
(Phone: 410/338-4514)

RELEASE: 94-77

HUBBLE FINDS MYSTERIOUS RING STRUCTURE AROUND SUPERNOVA 1987A

NASA's Hubble Space Telescope (HST) has obtained the best images yet of a mysterious mirror-imaged pair of rings of glowing gas that are encircling the site of the stellar explosion supernova 1987A.

One possibility is that the two rings might be "painted" by a high-energy beam of radiation or particles, like a spinning light-show laser beam tracing circles on a screen.

The source of the radiation might be a previously unknown stellar remnant that is a binary companion to the star that exploded in 1987. Images taken by Hubble show a dim object in the position of the suspected source of the celestial light show.

"The Hubble images of the rings are quite spectacular and unexpected," says Dr. Chris Burrows of the European Space Agency and the Space Telescope Science Institute in Baltimore, Md. Burrows used Hubble's Wide Field Planetary Camera 2 (WFPC 2) to image the rings in February 1994.

The striking Hubble picture actually shows three rings. The smaller "center" ring of the trio had been identified previously. The larger pair of outer rings also were seen in ground-based images, but the interpretation was not possible until the higher resolution Hubble observations.

-more-

Though all of the rings probably are inclined to our view (so that they appear to intersect), they probably are in three different planes. The small bright ring lies in a plane containing the supernova; the two rings lie in front of and behind it.

To create the beams illuminating the outer rings, the remnant would need to be a compact object such as a black hole or neutron star with a nearby companion. Material falling from the companion onto the compact object would be heated and blasted back into space along two narrow jets, along with a beam of radiation. As the compact object spins, it might wobble or precess about its axis, like a child's top winding down. The twin beam would then trace out great circles like jets of water from a spinning lawn sprinkler.

If the rings are caused by jets, however, the beams are extremely narrow (collimated to within one degree). This leads Burrows to conclude: "This is an unprecedented and bizarre object. We have never seen anything behave like this before."

The jet model explains why the rings appear to be mirror imaged, and why they appear to be symmetrical about a point offset from the center of the explosion.

Burrows got the idea for the beam explanation when he noticed that where a ring appears brighter, an equally bright region appears on the opposite ring. By connecting lines between the similar clumps on opposite rings, Burrows found a common center. However, it is offset from the heart of the supernova ejecta. When Burrows did a detailed inspection of the HST image, he found a dim object, which may be the source of the beams, at the predicted location. The object is about 1/3 light-year from the center of the supernova explosion.

From previous HST observations and images at lower resolution taken at ground-based observatories, astronomers had expected to see an hourglass-shaped bubble being blown into space by the supernova's progenitor star. "The rings are probably on the surface of the hourglass shape," says Burrows.

The hourglass was formed by a wind of slow-moving gas that was ejected by the star when it was a red supergiant, and a much faster wind of gas that followed during the subsequent blue supergiant stage. The hourglass was produced by the fact that the stellar wind from the red giant was denser in the equatorial plane of the star. When the star reached the blue supergiant stage, the faster winds tended to break out at the poles of the star.

-more-

Energetic radiation from the supernova explosion illuminated the dense gaseous material in the equatorial "waist" of the hourglass, causing it to glow -- thus explaining the central bright ring. However, the two outer rings might be painted on the surface of the hourglass by a very different process, by the beams from the stellar remnant.

Further observations with HST will study any additional changes that might occur. In particular, if a remnant companion really exists, it should collide with the supernova's expanding cloud of ejecta in the mid-1990s.

The observations were led by Dr. Chris Burrows in collaboration with the WFPC 2 Investigation Definition Team. The supernova is 169,000 light years away, and lies in the dwarf galaxy called the Large Magellanic Cloud, which can be seen from the southern hemisphere.

The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, Inc. (AURA) for NASA, under contract with the Goddard Space Flight Center, Greenbelt, Md. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency (ESA).

-end-

NOTE TO EDITORS: A color and a black and white image are available to news media from NASA's Broadcast and Imaging Branch. To obtain an image, please FAX your request to the Branch at 202/358-4333. The Photo numbers are: (color) 94-HC-153 and (b&w) 94-H-159.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Brian Dunbar
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release
May 20, 1994

Randee Exler
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-0697)

RELEASE No.: 94-78

NASA TAKES OVER LANDSAT 7 DEVELOPMENT CONTRACT

NASA officials announced today that the agency had assumed the satellite-development contract for Landsat 7 from the Department of Defense (DoD). The contract with Martin Marietta Astro Space, Valley Forge, Pa., will now be managed by NASA's Goddard Space Flight Center (GSFC), Greenbelt, Md.

Landsat 7 will provide essential land remote-sensing data critical to understanding environmental change and will support a broad range of other important Earth science and Earth-resource applications. The Landsat program has provided more than 20 years of calibrated data to a broad user community of resource managers, global-change researchers, state and local governments, commercial users and the military. Landsat data have been used, for example, to refine estimates of deforestation in the Amazon Basin.

NASA assumes satellite development following the Administration's reevaluation of the program, led by the Office of Science and Technology Policy (OSTP). Under the existing joint program office, DOD had primary responsibility for satellite development and launch, and NASA had primary responsibility for the ground system and data distribution.

The new program was implemented May 5 under a Presidential Decision Directive signed by President Clinton. NASA will have responsibility for development and launch of the satellite. The National Oceanic and Atmospheric Administration (NOAA) and NASA will jointly develop the ground system, which NOAA will operate. The Earth Resource Observation Satellites (EROS) Data Center, Sioux Falls, S.D., of the Department of Interior's U.S. Geological Survey (USGS) will continue to be responsible for maintaining the government's archive of Landsat and other related remotely sensed data.

-more-

The existing program was reevaluated after changing national security concerns led to DOD's determination that Landsat 7 would not meet its needs. DOD's withdrawal from the program, together with the failure of NOAA's Landsat 6 to reach orbit in October 1993 and the advanced age of Landsats 4 and 5, led the Administration to reassess the program.

The outcome of the OSTP's assessment is a new strategy designed to continue the Landsat program and extend the 20-year Landsat data set. The estimated cost of the restructured program (development and operations), including $230 million already spent, is $754.7 million, about $125 million less than the joint NASA-DOD program. Launch of Landsat 7 is planned for December 1998.

Landsat 7 is expected to be the functional equivalent of NOAA's Landsat 6, with enhancements to the spacecraft. Landsat 6 carried an Enhanced Thematic Mapper (ETM), which would have provided images of the Earth's surface with resolution as good as approximately 15 meters (50 feet) in one band plus 30 metters (100 feet) resolution in six bands covering the visible, near and short-wave infrared regions. Landsat 7 will carry an ETM-Plus, under development by Hughes Santa Barbara Research Center, Calif., which will provide modest improvements over Landsat 6, primarily in instrument calibration and accuracy.

Landsat 6 was intended to replace the existing Landsats 4 and 5. Launched in 1982 and 1984 respectively, Landsats 4 and 5 are operating well beyond their three-year design lives, and represent the only source of global, calibrated high spatial resolution measurements of the Earth's surface that can be compared to previous data records.

Landsat 7 is part of NASA's Mission to Planet Earth (MTPE), dedicated to studying how our global environment is changing. Using the unique perspective available from space, NASA is observing, monitoring and assessing large-scale environmental processes, with an emphasis on climate change. MTPE satellite data, complemented by aircraft and ground data, are enabling us to better understand environmental changes, to determine how human activities have contributed to these changes and to understand the consequences of such changes. MTPE data, which NASA is distributing to researchers worldwide, are essential to humans making informed decisions about protecting their environment.

The Landsat 7 spacecraft development is managed by GSFC for NASA's Office of Mission to Planet Earth, Washington, D.C.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Mark Hess/Jim Cast
Headquarters, Washington, D.C.
(Phone: 202/358-1778)

Debra Rahn
Headquarters, Washington, D.C.
(Phone: 202/358-1639)

Mary Ann Peto
Lewis Research Center, Cleveland
(Phone: 216/433-2902)

Kari Fluegel
Johnson Space Center, Houston
(Phone: 713/483-5111)

For Release
May 20, 1994

RELEASE: 94-79

STATION SOLAR ARRAY MODULES TO BE SENT TO RUSSIA

The first set of solar array modules for the International Space Station program are ready to be shipped from the United States to Russia at the end of May, NASA announced today.

The modules of interconnected solar cells are prototypes of flight units which will be delivered in September to be incorporated into advanced solar arrays for use on Russia's Space Station Mir. NASA and Russia's Space Agency are carrying out a joint program involving flights of the U.S. Space Shuttle to Mir and Russian participation in the International Space Station. The advanced array, known as the Cooperative Solar Array, combines Russian flight proven structures and mechanisms with American advanced solar array modules to increase the available user electrical power on the station.

"This project combines the best technology from both the United States and Russia," said Randy Brinkley, manager of the International Space Station Program Office. "It represents one more milestone that shows how all the international partners are committed to building a world-class research facility in space."

- more -

The modules will be delivered in two shipments. The first is tentatively scheduled to be sent May 30 with the second shipment tentatively set for June 15. Once they arrive in Russia, NPO-Energia will validate the design and assembly procedures prior to launch of the photovoltaic arrays to Mir on the Space Shuttle in October 1995 to support the joint Shuttle/Mir space flights. The six arrays for the International Space Station will be launched in 1998.

The Cooperative Solar Array team is structured as an Integrated Product Team (IPT) consisting of NASA's Lewis Research Center, Cleveland, Ohio; Rockwell International's Rocketdyne Division, Canoga Park, Calif.; Lockheed Missiles and Space Corporation, Sunnyvale, Calif.; and NPO-Energia, Kaliningrad. The IPT concept, which is being incorporated throughout the space station program, provides the necessary communications, flexibility and buy-in of all the team members and is critical to producing flight hardware in a reduced amount of time for lower cost. The Cooperative Solar Array project timeline will be less than two years from inception to deployment of the jointly produced array, making it one of the first pieces of hardware to be launched in the International Space Station program.

As the largest international scientific and technology development ever undertaken, the International Space Station will bring together resources from the United States, Russia, member nations of the European Space Agency, Canada and Japan. The first phase of the U.S./Russian program is a series of joint Shuttle/Mir space missions that will allow the United States to perform longer duration science experiments and verify station hardware concepts. Subsequently, the International Space Station will be assembled on-orbit with elements provided by the U.S., Russia, Europe, Japan and Canada. The first U.S. element launch will be in December 1997 with human-tended operations beginning in June 1998 after the launch of the U.S. laboratory. Assembly will be complete in 2002.

- end -

NOTE TO EDITORS: Three photographs of Lockheed technicians inspecting the solar array modules are available in the Johnson Space Center's Still Photo Library. To order the photos, please call 713/483-4231.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Sarah Keegan
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

For Release
May 23, 1994

NOTE TO EDITORS: N94-38

HUBBLE BRIEFING: EXISTENCE OF BLACK HOLE APPARENTLY CONFIRMED

A new Hubble Space Telescope (HST) image of a whirlpool of hot gas in the core of elliptical galaxy M87 will be the subject of a media briefing on Wednesday, May 25, 1994, at 1:00 pm EDT in the NASA Headquarters Auditorium, 300 E St., SW, Washington, D.C.

HST measurements of the velocity of this whirlpool provide seemingly conclusive evidence for a massive black hole in the center of the galaxy.

Presenting their findings in a "Space Astronomy Update" will be Holland Ford of the Space Telescope Science Institute and The Johns Hopkins University in Baltimore, Md., and Dr. Richard Harms of the Applied Research Corp., Landover, Md.

Host Dr. Stephen Maran of NASA's Goddard Space Flight Center, Greenbelt, Md., will be joined by Dr. Bruce Margon, Professor of Astronomy and Chairman of the Department of Astronomy, University of Washington, Seattle, and Dr. Daniel Weedman, Director, Astrophysics Division, Office of Space Science, NASA Headquarters.

Copies of the new HST image will be available at the briefing.

This event will be carried live on NASA Television, Spacenet 2, 69 degrees west longitude, Transponder 5 (Channel 9), frequency 3880 MHz, horizontal polarization. Immediately before and after the program there will be a clean video feed of graphics and animation.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Terri Sindelar
Headquarters, Washington, D.C.
(Phone: 202/358-1977)

Mike Braukus
Headquarters, Washington, D.C.
(Phone: 202/358-1979)

For Release
May 23, 1994

RELEASE: 94-80

NASA AND MULTIPLE SCLEROSIS ASSOCIATION TO COLLABORATE

NASA and the Multiple Sclerosis Association of America (MSAA) today signed an agreement to work collaboratively to advance the state of the art and application of cool suit technology for MS patients.

"This collaboration presents several unique opportunities for NASA and, most importantly, for MS patients," said Daniel S. Goldin, NASA Administrator. "The MSAA and NASA hope to advance cool suit technology to further relieve symptoms of thousands of MS patients nationwide."

More than 300,000 Americans, the majority of whom are women, are afflicted with this progressively disabling neurological disease that has no known cause, cure or prevention. Currently, about 1,000 MS patients use the current cool suit for systematic relief.

NASA's liquid cooled suit technology, called microclimate cooling, was developed for use as a space suit undergarment for cooling astronauts on the surface of the moon or during space walks.

"The wealth of technology that comes from the exploration of air and space is a valuable national resource and an investment in America's future. Technology transfer is a fundamental mission of NASA," Goldin continued. "This collaborative effort is one in a series of initiatives to open our door to industry, academia and other organizations seeking to tap into NASA's high technology network."

Scientists and engineers at NASA's Johnson Space Center, Houston, and Ames Research Center, Mountain View, Calif., will work with members of the MSAA to enhance the performance of cool suits for this application. The Office of Life and Microgravity Sciences and Applications Extravehicular Activity Working Group, comprised of government, industry and academia, will lead the effort for NASA.

- more -

Cool Suit

The liquid cooled suit is a light-weight, head and vest garment that helps remove the heat generated by the body and lowers the overall temperatures by approximately one degree. By using this suit, certain individuals with MS have reported some improvements with speech, vision, the use of arms and legs, and cognitive abilities.

Madlyn Rhue, actress, artist, native Washingtonian and MS patient, participated in today's event and demonstrated how NASA's cool suit technology has relieved her symptoms and improved her quality of life.

Today's ceremony was held at the National Rehabilitation Hospital, the Washington, D.C. area's only rehabilitation facility. The hospital conducts research on cool suit technology and other advanced technologies to help MS patients reduce disabling symptoms.

Edward A. Eckenhoff, President and CEO of NRH, led a tour of the hospital's unique facilities where doctors and MS patients discussed the research and benefits of the technology.

NASA's liquid cooled suit technology has found other applications in the medical field, including aiding patients who are born without sweat glands. It has also found applications in hot environments where body heat dissipation is difficult, such as cooling race car drivers and others in the athletic industry, patients of post-surgical hypothermia therapy, and soldiers in the Persian Gulf War.

National Service and Liaison to Non-profit Community

"President Clinton is committed to working with the non-profit community to forge partnerships," Goldin said. "One of NASA's basic values and operating principles is to be responsible to the American public. This new partnership with MSAA, and the promise of helping thousands of MS patients using our technology assets, inspires our missions and motivates our workforce."

President Clinton created a Non-profit Liaison Network, comprised of 25 Administration officials from every principal department and most agencies, to strengthen partnerships between government and the non-profit sector to support the work of service groups.

The main mission of NASA's National Service Office is to use the agency's resources to address pressing social needs of the Nation, particularly in education public safety and the environment.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Don Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release

May 24, 1994

RELEASE: 94-81

NASA AND AMERICAN GEOPHYSICAL UNION HONOR JAMES A. VAN ALLEN

NASA and the American Geophysical Union (AGU) honored pioneering space scientist Dr. James A. Van Allen, Professor Emeritus at the University of Iowa in a ceremony on his 80th birthday. The ceremony was held at the AGU's 75th anniversary meeting in Baltimore, Md., today.

NASA presented Dr. Van Allen with an original computer painting commemorating his distinguished half-century career studying planetary magnetospheres and cosmic rays. Dr. Van Allen is most well-known for his discovery of the belt of radiation around the Earth that bears his name. His radiation-measuring equipment aboard the first successful American satellites, Explorers 1 and 3, launched in 1958, provided data for the first space-age scientific discovery -- the existence of a doughnut-shaped region of charged particle radiation trapped by the Earth's magnetic field.

Dr. Van Allen and his team also provided instruments for other NASA missions including energetic charged particle detectors aboard the Venus-bound Mariner 2 and Mars-bound Mariner 4, an energetic charged particle detector on the Explorer 35 (the first American spacecraft to orbit the Moon), and energetic charged particle detectors aboard the Jupiter-bound Pioneers 10 and 11. Dr. Van Allen's instruments aboard Pioneer 10 contributed to the discovery of the magnetosphere and radiation belts of Jupiter and the radiation belts of Saturn. In addition to studying Jupiter and Saturn, Dr. Van Allen and his team used Pioneer 10 and 11 data to study the galactic cosmic rays in the solar system.

The AGU's Space Physics and Aeronomy Section also sponsored a special Van Allen Symposium featuring invited speakers on past accomplishments, recent important results and future prospects in a number of areas in which Dr. Van Allen has made significant contributions.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Sarah Keegan
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release
May 25, 1994
Embargoed for 1 p.m. EDT

Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

Ray Villard
Space Telescope Science Institute, Baltimore, Md.
(Phone: 410/338-4514)

RELEASE: 94-82

HST CONFIRMS EXISTENCE OF MASSIVE BLACK HOLE IN ACTIVE GALAXY

Astronomers using NASA's Hubble Space Telescope (HST) have found seemingly conclusive evidence for a massive black hole in the center of the giant elliptical galaxy M87, located 50 million light years away in the constellation Virgo. Earlier observations suggested the black hole was present, but were not decisive.

This observation provides very strong support for the existence of gravitationally collapsed objects, which were predicted 80 years ago by Albert Einstein's general theory of relativity.

"If it isn't a black hole, then I don't know what it is," says Dr. Holland Ford of the Space Telescope Science Institute (STScI) and The Johns Hopkins University in Baltimore, Md.

"A massive black hole is actually the conservative explanation for what we see in M87. If it's not a black hole, it must be something even harder to understand with our present theories of astrophysics," adds fellow investigator Dr. Richard Harms of the Applied Research Corp., Landover, Md.

The discovery is based on velocity measurements of a whirlpool of hot gas that is orbiting around the black hole in the form of a disk. The presence of the disk, discovered in recent Hubble images, allows for an unprecedented, precise measurement of the mass of the object at the hub of the disk.

-more-

A black hole is an object that is so massive yet compact nothing can escape its gravitational pull, not even light. The object at the center of M87 fits that description. It weighs as much as three billion suns, but is concentrated into a space no larger than our solar system.

Now that astronomers have seen the signature of the tremendous gravitational field at the center of M87, it is clear that the region contains only a fraction of the number of stars that would be necessary to create such a powerful attraction. There must be something else there that cannot be seen.

Ford and Harms were astounded by the M87 images taken with the telescope's Wide Field Planetary Camera-2 (in Planetary Camera mode) on Feb. 27. They hadn't anticipated seeing such clear evidence of a gaseous disk in the center of M87.

"It's just totally unexpected to see the spiral-like structure in the center of an elliptical galaxy," Ford says.

Ford and Harms used HST's Faint Object Spectrograph to measure the speeds of orbiting gas on either side of the disk from regions located about 60 light-years from the black hole at the center.

They calculated that the disk of hot (about 10,000 degrees Kelvin), ionized gas is rotating at tremendous speeds around a central object that is extremely massive but extraordinarily compact -- a black hole.

"Once you get that measurement, all you need is straightforward Newtonian physics to calculate the mass of the central object that's making the disk spin," says Harms.

The measurement was made by studying how the light from the disk is blue-shifted and red-shifted -- as one side of the disk spins toward us and the other side spins away from us. The gas on one side of the disk is speeding away from Earth, at a speed of about 1.2 million miles per hour (550 kilometers per second). The gas on the other side of the disk is whipping around at the same speed, but in the opposite direction, as it approaches viewers on Earth.

"Now, it all knits together," Ford said. "We see a disk-like structure that appears to have spiral structure, and it's rotating. One side is approaching and the other is receding."

The cloud of gas is composed mostly of hydrogen. The hydrogen atoms have been ionized, or stripped of their single electron, possibly by radiation originating near the black hole.

-more-

Over the next few months, they will attempt to peer even closer to the center, where the disk should be spinning at even higher speeds, improving the measurement of the black hole's mass.

M87: A NEARBY ACTIVE GALAXY

Since observations as early as 1917, astronomers have suspected that unusual activity was taking place in the center of M87. They discovered a long finger of energy emanating from the nucleus. Investigations using radio telescopes in the 1950s detected large emissions of energy from the galaxy. This made it clear that the bright optical jet and radio source were the result of energy released by something in the center of the galaxy.

In high resolution images, the jet appears as a string of knots (some as small as ten light-years across) within a widening cone extending out from M87's core. A massive black hole had been the suspected "engine" for generating the enormous energies that power the jet. The gravitational energy is released by gas falling into the black hole, producing a beam or jet of electrons spiraling outward at nearly the speed of light.

HUNTING FOR BLACK HOLES

HST's observation confirms more than two centuries of theory and conjecture about the reality of black holes. The term "black hole" was coined in 1967 by American physicist John Wheeler. However, French scientist Simone Pierre LaPlace first speculated that "dark stars" might exist, which would have such intense gravitation that light itself could not escape. This conjecture was put into a theoretical framework with Einstein's general theory of relativity, published in 1915, which postulated that very massive objects actually warp space and time. The theory was supported in 1916 when German physicist Karl Schwarzschild described the mathematical basis behind black holes.

For decades, however, black holes were regarded not as real astronomical objects, but merely as mathematical curiosities. With the discovery of active galaxies and quasars, black holes have become the favored "engine" for explaining a wide array of powerful and energetic events seen in the universe.

Earlier HST observations found strong circumstantial evidence for the presence of a massive black hole in the core of M87, as well as other galaxies -- both active and quiescent. These observations show a rapid increase in starlight toward the center of a galaxy. This suggests that stars are concentrated around the center due to the gravitational pull of a massive black hole. However, the black hole's mass could not be determined until HST's spectroscopic capabilities were used to measure the actual motion of gas around the black hole. Such high spatial resolution spectroscopic observations were not possible prior to the installation of the COSTAR by the astronauts during the December 1993 First Servicing Mission.

The research team included Holland Ford at the Johns Hopkins University and STScI; Richard Harms at Applied Research Corp.; and astronomers Zlatan Tsvetanov, Arthur Davidsen, and Gerard Kriss at Johns Hopkins; Ralph Bohlin and George Hartig at STScI; Linda Dressel and Ajay K. Kochhar at Applied Research Corp.; and Bruce Margon from the University of Washington in Seattle.

The STScI is operated by the Association of Universities for Research in Astronomy, Inc. (AURA) for NASA, under contract with the Goddard Space Flight Center, Greenbelt, Md. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency (ESA).

- end -

NOTE TO EDITORS: Color and black and white images are available to news media from NASA's Broadcast and Imaging Branch. To obtain images, please fax your request to the Branch at 202/358-4333. The photo numbers are: (Color) 94-HC-154 and 94-HC-155 and (B&W) 94-H-161 and 94-H-162.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

For Release

May 25, 1994

Michael Braukus
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

James H. Wilson
Jet Propulsion Laboratory, Pasadena, Calif.
(Phone: 818/354-5011)

RELEASE: 94-83

NEW GALILEO ASTEROID MOON IMAGES, DATA RELEASED

New pictures of the asteroid 243 Ida and its newly discovered moon taken by NASA's Galileo spacecraft were released today by mission scientists.

New data from Galileo suggest that although Ida and its natural satellite -- the first asteroid moon ever photographed -- are similar in color and brightness, they appear to be composed of different types of material, the scientists said.

The scientists also reported that new results show that Ida is more irregular in shape than Gaspra, another asteroid which the Galileo spacecraft encountered two years earlier.

Galileo took multiple images of Ida seen from different angles as the asteroid rotated during the spacecraft encounter.

Scientists also used the images to begin estimating an orbit for the asteroid's tiny moon. Its motion, in the same direction as Ida's rotation, appears to be in a plane viewed nearly edge-on by the spacecraft -- making it difficult to determine the exact orbital shape and period.

"A circular orbit at 60 miles (90 kilometers), nearly in Ida's equatorial plane, with a period of about one Earth day, appears to fit the observations we have now," said Kenneth P. Klaasen, a member of the imaging team.

"However, a range of elliptical orbits cannot be ruled out yet," he added. "Other observations that are still on Galileo's onboard tape recorder -- to be played back next month -- should permit us to improve the calculation."

- more -

There are different explanations for the origin of Ida's one mile-diameter (1.5-kilometer) moon. It might be a large block thrown off during an impact that formed one of the large craters visible on Ida's surface.

"More likely," said imaging team member Dr. Clark Chapman, "the moon was formed during the cataclysmic fragmentation and disruption of a larger asteroid in which Ida itself was formed.

"In this scenario, the little moon was ejected from the explosion in practically the same orbit as Ida, and was captured in the larger object's gravitational field," Chapman continued, "while most other fragments went into independent orbits around the Sun."

Galileo's near-infrared mapping spectrometer, which initially confirmed the discovery of Ida's moon, provided the data for thermal and mineralogical maps of the surface of Ida and mineralogical studies of its moon.

"We have good data on what minerals make up these bodies, " said Dr. Robert Carlson, principal investigator for the spectrometer. "The areas on Ida's surface where we have our best data appear to be predominantly olivine, with a bit of orthopyroxene -- while its moon is quite different, with a roughly equal mixture of olivine, orthopyroxene and clinopyroxene."

"This suggests the moon is not a chip off the asteroid."

These and other results from the Ida encounter will be discussed by the Galileo scientists in a special session of the American Geophysical Union's spring 1994 meeting in Baltimore, Md., on Thursday, May 26.

Ida orbits the Sun at an average distance of 270 million miles (440 million kilometers) in about the middle of the asteroid belt between Mars and Jupiter. The asteroid is about 36 miles (58 kilometers) long and 14 miles (23 kilometers) wide, and rotates once every 4 hours, 40 minutes. One of only two asteroids ever observed close-up, it was encountered Aug. 28, 1993, by the Galileo spacecraft on its way to Jupiter.

Pictures and other scientific data taken during the flyby were stored on Galileo's onboard tape recorder; playback is still underway. Ida's moon was discovered in data played back and analyzed in February and March 1994.

Galileo executed its other asteroid flyby, of the rocky body Gaspra, on Oct. 29, 1991.

NASA's Jet Propulsion Laboratory, Pasadena, Calif., manages the Galileo project for NASA's Office of Space Science, Washington, D.C.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Michael Braukus
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release
May 26, 1994
Embargoed until 12:30 p.m. EDT

RELEASE: 94-84

CLEMENTINE PRODUCES FIRST GLOBAL DIGITAL MAP OF MOON

The Clementine mission, sponsored by the Department of Defense Ballistic Missile Defense Organization, has completed systematic mapping of the Lunar surface to produce the first global digital map of the Moon. NASA's Clementine science team has mapped the topography and composition of major regions of the Moon in detail and produced other important science results released today at the spring meeting of the American Geophysical Union in Baltimore, Md.

The digital data set covers 38 million square kilometers of the Moon mapped in 11 colors in the visible and near infrared parts of the spectrum during the mission's 71 days in lunar orbit, providing the first view of the global color of the Moon.

"The scientific significance of the lunar data set from Clementine is immense. For the first time, multi-spectral imaging data of consistent viewing geometry, resolution, and lighting conditions have been obtained for the entire Moon," said Dr. Jurgen Rahe, NASA Program Scientist. "With Clementine data, we have begun a new era in the exploration of the geology of the planets using global multi-spectral data sets."

Composition of Lunar Surface Studied

The color of the Moon in the visible to near infrared part of the spectrum is sensitive to variations in both the mineral composition of surface material and the amount of time that material has been exposed to space. Color filters for the two principal mapping cameras, the ultraviolet-visible camera and the near infrared camera, were selected to characterize the overall surface composition and to search for titanium-rich rocks.

By combining information obtained through 11 filters, multi-spectral image data are used to map the distribution of rock and soil types on the Moon. Preliminary studies of areas of already known geological complexity, including the Aristarchus crater and plateau, the Copernicus crater and the crater Giodano Bruno, allow scientists to identify and map the diversity within and between geologic areas which have both impact and volcanic origins.

- more -

The mission also provided tens of thousands of high resolution and mid-infrared thermal images. The topography of the Moon was mapped using a laser ranger. Knowledge of the surface gravity field of the Moon was improved through analysis of radio tracking data. A Charged Particle Telescope characterized the solar and magnetospheric energetic particle environment.

Surface and Subsurface Structure

In addition to compositional data from the images, Clementine has produced views of either previously unknown regions of the Moon or previously known areas from a different and unique perspective, in both cases yielding new insights into lunar evolution.

Scientists measured the topography of large, ancient impact features, including the largest (1,600 miles/2,500 km in diameter) and deepest (more than seven miles/12 km) impact basin known in the Solar System. Preliminary analysis has deciphered the gravity structure of a young basin on the limb of the Moon, showing that a huge plug of the lunar mantle has been uplifted from below its surface.

The Science Team completed a mosaic of the South Polar region of the Moon using over 1,500 images obtained during the first month of systematic mapping. A striking result from this mosaic, depicted by an extensive region of shadow, is the discovery of a large depression centered very near the South Pole. Scientists believe this is almost certainly an ancient impact basin about 190 miles (300 km) in diameter. They also believe that large parts of this dark area may never receive any sunlight because the Moon's rotation axis is nearly perpendicular to the plane of its orbit around the Sun.

If this region receives no sunlight, it possibly will be about minus 230 degrees Celsius. This fact is significant because water molecules from impacting comets may have found their way into such 'cold traps' and accumulated in significant amounts over billions of years. Clementine beamed radio waves into the polar areas and the scattered radio signals were received by the large antennas of NASA's Deep Space Network. This 'bistatic radar' experiment was designed to look for echoes that would indicate the presence of water ice deposits. The results of this experiment may not be known for many months as the data will require thorough analysis.

Topographic and Gravity Studies

Laser ranging data from Clementine allow a nearly global view of topography (or relief) of the lunar surface. A striking result from these data is the confirmation of a population of very ancient, nearly obliterated impact basins, randomly distributed across the Moon. The presence of these basins was inferred from obscure circular patterns found in photographs taken by NASA's Lunar Orbiter spacecraft in the 1960s.

Clementine laser ranging has provided dramatic confirmation of their existence, including their surprising depth, typically three to four miles (five to seven km), even for the most degraded features.

Another major result is the confirmation of the largest impact basin on the Moon, the 1,600 mile (2,500 km) diameter South Pole-Aitken basin. This feature is about over seven and one-half miles (12 km) deep, making it the largest and deepest impact crater known in the Solar System.

Gravity data obtained from radio tracking of Clementine indicate that these great holes in the Moon's crust are compensated by structural uplift of dense rocks from the mantle beneath each impact basin.

The Clementine data, together with the lunar rock and soil samples of known geologic context which were returned to Earth from the Apollo and Luna programs, constitute unique data sets which do not exist for any other body in the Solar System, including the Earth. On the basis of the initial study of the Clementine data, new insights are likely into how the Moon has evolved over its protracted and complex history. NASA plans to sponsor a multi-year peer-reviewed program of lunar data analysis, which will include the extensive Clementine data sets.

- end -

NASA News
National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Terri Sindelar
Headquarters, Washington, D.C.
(Phone: 202/358-1977)

For Release
May 27, 1994

RELEASE: 94-85

NASA AWARDS RESEARCH GRANTS TO HISPANIC SERVING INSTITUTIONS

NASA today announced the selection of six Hispanic Serving universities to receive five-year, Institutional Research Award (IRA) grants for multidisciplinary research in science and engineering.

The universities will receive $400,000 the first year, $600,000 the second year, $800,000 the third year and $1 million in the fourth and fifth years, totalling $3.8 million over the five-year period.

The grant program targets institutions of higher education, especially Hispanic Serving Institutions that meet the eligibility criteria outlined in Public Law 102-325 in the higher education amendments of 1992, Tribal Colleges and other minority universities whose student enrollment of underrepresented minorities exceeds 50 percent.

The grants will provide an increased opportunity for eligible institutions and underrepresented minorities to participate in and benefit from NASA and federal research programs by strengthening their capacity to perform research and by providing a learning and research environment for students. Three of the research projects are in engineering, two in Earth science and one in space science.

The universities selected to receive grants are:

- California State University at Los Angeles
- Florida International University, Miami
- New Mexico Highlands University, Las Vegas
- The City College of New York
- University of Puerto Rico, Rio Piedras
- University of Texas at San Antonio

The IRA grant program is sponsored by the NASA Office of Equal Opportunity Programs in collaboration with NASA Headquarters program offices and installations and the Jet Propulsion Laboratory in Pasadena, Calif.

\- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

For Release

Brian Dunbar
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

May 27, 1994

RELEASE: 94-86

UNUSUAL HIGH ENERGY FLASHES SEEN IN EARTH'S ATMOSPHERE

Scientists at NASA's Marshall Space Flight Center in Huntsville, Ala., have discovered unusual gamma-ray flashes in the upper atmosphere high above thunderstorms.

These high energy bursts have never before been seen in the Earth's atmosphere or surrounding space, according to Dr. Gerald Fishman of Marshall's Space Science Laboratory.

These flashes were detected by the Burst and Transient Source Experiment (BATSE), a Marshall instrument aboard NASA's orbiting Compton Gamma Ray Observatory.

"It is suspected that these flashes come from a rare type of powerful electrical discharge, similar to lightning, above large thunderstorm regions," Fishman said. The observations were published in this week's issue of *Science*, an international scientific journal.

"The flashes are very brief, lasting only a few thousandths of a second, although some of them consist of multiple pulses." They are seen very infrequently: only about twenty have been seen since the observatory was launched in April 1991 from the Space Shuttle Atlantis.

"We saw our first flash of this type the first week that the detectors were turned on. We didn't know what to make of it," said Fishman. In order to detect gamma rays with space-borne detectors, they must be produced at altitudes above 100,000 feet. This is considerably higher than normal weather processes, according to Fishman.

The observations have been confirmed by other instruments on the observatory. The BATSE detectors on the observatory were originally designed for sensitive observations of celestial objects in wavelength regions unobservable from the ground.

-more-

"The gamma-ray observations from the Earth's atmosphere come as a complete surprise to us. Atmospheric scientists are also surprised," said Fishman.

"For many years, aircraft pilots have reported 'upward-going' lightning in clear air over thunderstorms. But these reports were either never taken seriously or were never studied in a scientific manner," he said.

In recent years, there have been video observations of electrical discharges above thunderstorms taken from the Space Shuttle and from research aircraft. The new gamma-ray flash observations may be related to these optical observations, Fishman said.

"It is becoming apparent that the upper atmosphere is much more electrically active than we ever suspected," he concluded.

-end-

NASA News
National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

For Release

Ed Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1778)

May 27, 1994

Kyle Herring
Johnson Space Center, Houston
(Phone: 713/483-5111)

RELEASE: 94-87

ASTRONAUT WILLIAM THORNTON RETIRES FROM NASA

Space Shuttle astronaut Dr. William E. Thornton will retire from NASA on May 31. Thornton, a member of the astronaut class of 1967, flew twice aboard the Shuttle -- on STS-8 in August/September 1983 and aboard STS 51-B in April/May 1985.

On STS-8 aboard Challenger, Thornton made near continuous measurements and investigations of adaptation of the human body to weightlessness which included a number of first-time measurements on the human nervous system in space using equipment he designed.

During his second mission, also on Challenger, Thornton was responsible for the first animal payload aboard a Shuttle mission. He also continued space medicine studies in the pressurized Spacelab module in the orbiter's payload bay.

Thornton received his doctorate in medicine from the University of North Carolina (UNC) in 1963 after obtaining a bachelor of science degree in physics from UNC in 1952. Prior to the Shuttle program, Thornton was the principal investigator for a Skylab medical experiment and documented a number of basic responses of the human body to weightlessness, including alterations in body posture and shape, and rapid loss of muscle strength and mass along with preventive methods. He devised the first mass measuring devices used in space on Skylab, which are still in use. Thornton has recently designed and tested smaller, improved units to allow routine mass measurement in space.

"Bill has contributed greatly to operational studies in space throughout his career," said David C. Leestma, director of Flight Crew Operations. "His expertise will be greatly missed."

- more -

Thornton's immediate plans include writing about his work over the last 30 years in the space program. "Due to my work, I haven't really had the opportunity, or the time to do any writing about my technical work other than a few reports, and none at all about other matters."

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Dwayne C. Brown
Headquarters, Washington, D.C.
(Phone: 202/358-1600)

For Release
June 1, 1994

RELEASE: 94-88

NASA DEDICATES RESEARCH FACILITY IN WEST VIRGINIA

NASA today held a ceremonial dedication of the Independent Verification and Validation (IV&V) facility, a new research facility in Fairmont, West Va., that will support the agency's work in advanced research, stimulate commercialization efforts and provide training in a variety of engineering and technology areas.

Participants in the dedication included Senator Robert C. Byrd, Congressman Alan Mollohan (D-WVa.), West Virginia University (WVU) President Neil Bucklew and many others representing the cooperative venture between WVU and NASA.

"West Virginia is developing into a major high-tech area. This facility will be a prime example of government, industry and academia working together to develop faster, better and cheaper aerospace systems for our nation," said NASA Administrator Daniel S. Goldin.

The IV&V facility will house approximately 200 civil and contractor employees working on a variety of tools, techniques and applications for systems software. NASA's Office of Safety and Mission Assurance (OSMA), Washington, D.C., will manage and operate the facility.

"This software is essential to the successful operation of NASA ground systems, spacecraft and aeronautical computers and their operating hardware," said Charles Mertz, Director, IV&V.

Software engineers will perform IV&V functions for the International Space Station. The facility also will house portions of the Earth Observing System (EOS) Data and Operations System. This will be EOS's main center for distribution of EOS data to the EOS data archives for study by U.S. and international principal investigators. EOS is the centerpiece of NASA's Mission to Planet Earth, involving a 20-year study of Earth, focusing on climate change.

-more-

In addition, the facility will work closely with WVU to develop and conduct a graduate-level program in the safety, reliability and quality assurance discipline. This program will evolve into a certified two-year curriculum, with students earning masters degrees in assurance technology. Assurance technology is the field of testing, analysis and risk management that increases the successful operation of flight systems.

"Fairmont was chosen for its strong sense of community teamwork, its expanding role in the academic community and its proximity to high-tech organizations in the area. This area should provide significant contributions to our nation's competitiveness in the areas of research and technology," Mertz said.

The overall goal of the IV&V facility is to become a Center of Excellence. Centers of Excellence were created in 1990 by NASA to develop NASA field centers as world leaders in specific areas of science, technology and research and development.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 358-1600

Mark Hess
Headquarters, Washington, D.C.
(Phone: 202/358-0902)

For Release

June 3, 1994

RELEASE: 94-89

NASA AND CSA ANNOUNCE SPACE COOPERATION PLAN

NASA and the Canadian Space Agency (CSA) announced today that they have reached an agreement, in principle, which will put U.S./Canadian space cooperation on a long-term, stable footing.

The arrangement between the two space agencies provides for expanded and enhanced cooperation in a number of areas such as space science, microgravity research and the Mission to Planet Earth, and Canada's continuation as a full partner in the International Space Station program.

"I am very pleased that Canada will remain a full partner in the International Space Station program," said NASA Administrator Daniel S. Goldin. "Canada's participation is extremely important to the success of this program," he said.

CSA will retain responsibility for developing the Mobile Servicing System for the Space Station. To that end, CSA will complete the development of the Space Station Remote Manipulator System and the Mobile Remote Servicer Base System. CSA also will complete the detailed design of the Special Purpose Dexterous Manipulator (SPDM), but will defer the decision on whether to manufacture the SPDM until 1997.

NASA and CSA also agreed to consider expanded cooperation in other areas. NASA and CSA are exploring cooperation on the Radarsat-2 program, building on the already agreed Radarsat-1 cooperation in which CSA provides the spacecraft and NASA contributes a medium class launch.

CSA also has proposed two cooperative science small satellite (smallsat) missions under Canadian mission management to be developed with NASA's participation. NASA and CSA will establish a joint study group to define the science priorities and other details for specific cooperative projects. Based on the recommendation of the joint study group, NASA and CSA will pursue a detailed agreement where NASA would provide selected experiments and up to two small class launches.

- more -

NASA and CSA also have agreed on new joint microgravity activities using DC-9 aircraft and sounding rockets. This will be done on a primarily cooperative basis, with NASA and CSA sharing most of the data from the missions.

In addition, NASA will provide opportunities for one Canadian astronaut flight per year during the Space Shuttle/Mir Space Station docking missions and Space Station assembly.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 358-1600

For Release

June 3, 1994

Mark Hess
Headquarters, Washington, D.C.
(Phone: 202/358-0902)

Kyle Herring
Johnson Space Center, Houston
(Phone: 713/483-5111)

RELEASE: 94-90

CREW NAMED FOR FIRST SPACE SHUTTLE, MIR DOCKING MISSION

A seven-member Space Shuttle crew, led by veteran astronaut Robert L. "Hoot" Gibson (Captain, USN), will launch next year to perform the first docking with the Russian Space Station Mir to exchange crews.

Joining Gibson on the mission will be Pilot Charlie Precourt (Lt. Col., USAF) and Mission Specialists Dr. Ellen Baker, Greg Harbaugh and Bonnie Dunbar. Russian cosmonauts Anatoly Solovyev and Nikolai Budarin will serve as the Mir-19 crew and replace Vladimir Dezhurov, Gennadiy Strekalov and astronaut Norman Thagard who are scheduled to be launched aboard a Soyuz spacecraft next March for a three month stay on the Space Station as the Mir-18 crew.

STS-71 is currently scheduled for launch in mid-1995 using the orbiter Atlantis, which has been modified to carry a docking system compatible with the Russian Mir Space Station.

The orbiter will carry a Spacelab module in the payload bay in which various life sciences experiments and data collection will take place throughout the 10-day mission.

Gibson, 47, currently Chief of the Astronaut Office, will be making his fifth flight aboard the Shuttle. His most recent mission was commander of Endeavour's STS-47 flight in September 1992, a cooperative Spacelab mission with Japan.

- more -

Gibson's first flight as pilot of STS 41-B was in February 1984 aboard Challenger. That flight included deployment of two satellites and the first use of the free-flying Manned Maneuvering Unit by an astronaut. The eight-day mission ended with the first landing at the Kennedy Space Center, Fla.

The STS 61-C flight of Columbia in January 1986 was Gibson's second mission and first as commander. The six-day flight included a communications satellite deployment and the conduct of several astrophysics and materials processing experiments. He next commanded Atlantis' STS-27 Department of Defense mission in December 1988.

Gibson considers Lakewood, Calif., to be his hometown. Active in the Navy since 1969, he holds a bachelor of science degree in aeronautical engineering from California Polytechnic State University.

Precourt, 38, will be making his second Shuttle flight. Since his first mission aboard Columbia in April 1993, Precourt has served in Mission Control as an ascent and entry spacecraft communicator (CAPCOM).

His first Shuttle flight, STS-55, was a German-sponsored Spacelab mission during which nearly 90 experiments investigating life sciences, materials sciences, physics, robotics, astronomy and the Earth and its atmosphere were conducted.

Precourt considers Hudson, Mass., to be his hometown. He has a master of science degree in engineering management from the U.S. Air Force Academy in 1977 and a master of arts degree in national security affairs and strategic studies from the U.S. Naval War College in 1990.

Baker, 41, was a mission specialist on two previous flights: STS-34 in October 1989 and STS-50 in June 1992. Prior to this assignment, Baker has been working Space Station operations issues.

Her first flight aboard Atlantis started the mission of the Galileo spacecraft currently on its way to study Jupiter. Her second mission was aboard Columbia on the first United States Microgravity Laboratory (USML-1) mission lasting two weeks. This first Extended Duration Orbiter flight included experimentation in crystal growth, fluid physics, fluid dynamics, biological science and combustion science.

Baker considers New York City her hometown. She received her doctorate of medicine degree from Cornell University in 1978.

Harbaugh, 38, has flown twice in space as a mission specialist: STS-39 aboard Discovery in April 1991 and on Endeavour's STS-54 mission in January 1993. Since that flight he has served as a CAPCOM in Mission Control and as the backup spacewalking expert for the Hubble Space Telescope servicing mission last year.

Harbaugh's first mission was the unclassified Department of Defense flight on which he operated the Shuttle's Remote Manipulator System (RMS) or Shuttle robot arm and the Infrared Background Signature Survey spacecraft.

Harbaugh's most recent flight included deployment of the Tracking and Data Relay Satellite and a spacewalk designed to refine training methods, and expand the experience of ground controllers, instructors and astronauts leading to assembly of the International Space Station.

Harbaugh's hometown is Willoughby, Ohio. He received a master of science degree in physical science from the University of Houston-Clear Lake in 1986.

Dunbar, 44, is currently training as the backup crew member to Norm Thagard for the Soyuz-Mir 18 mission in Star City, Russia. STS-71 will be her fourth Shuttle flight. She was a mission specialist on STS 61-A in October 1985, STS-32 in January 1990 and STS-50 in 1992.

Challenger's STS 61-A mission was the first German-sponsored Spacelab flight (Spacelab D-1). It was the first mission to carry eight crew members and the first that saw payload activities controlled from outside the U.S. More than 75 experiments were conducted during the seven-day flight.

Dunbar next flew aboard Columbia on the STS-32 mission to retrieve the Long Duration Exposure Facility which she secured using the RMS.

Most recently she flew aboard Columbia as the payload commander on the first United States Microgravity Laboratory (USML-1) mission.

Dunbar was born in Sunnyside, Wash. She received her doctorate in biomedical engineering from the University of Houston in 1983.

Solovyev and Budarin will serve as the next crew to stay for an extended period aboard the Mir Space Station and are designated the Mir-19 crew. Solovyev, 45, was born in Riga, Latvia, but resides in Star City, Russia.

Budarin, 40, was born in Chuvash Autonomous Republic, Kirya, Altir region. He lives in Kaliningrad outside of Moscow, Russia.

Solovyev and Budarin will switch places with the Mir-18 crew (Dezhurov, Strekalov and Thagard) which is scheduled to conduct three months of experiments aboard Mir before returning to Earth aboard Atlantis with the other five crew members.

Thagard, 50, has flown four times on the Shuttle and will be a member of the Mir-18 crew scheduled for launch aboard a Soyuz spacecraft from the Baikonur Cosmodrome in Kazakhstan.

Thagard's Shuttle missions include STS-7 in June 1983 and STS 51-B in April 1985, both aboard Challenger; STS-30 in May 1989 on Atlantis, and STS-42 in January 1992 aboard Discovery.

STS-7 was the first mission with a crew of five and the first to deploy and retrieve a spacecraft using the RMS. Two satellites also were deployed during the flight. Thagard's second flight was a Spacelab mission that included a research animal holding facility carrying 24 rats and two monkeys.

His third flight deployed the successful Magellan spacecraft that continues to orbit Venus. Thagard's most recent mission was the first International Microgravity Laboratory (IML-1) flight that included 55 experiments provided by investigators from 11 countries.

Dezhurov, 32, was born in Mordov Autonomous Republic, Yavas, Zubo-Polyansky district. He resides in Star City.

Strekalov, 53, was born in Mitishchi outside of Moscow, Russia and now resides in Moscow.

- end -

NASA News
National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 358-1600

Charles Redmond
Headquarters, Washington, D.C.
(Phone: 202/358-1757)

For Release

June 6, 1994

RELEASE: 93-91

NASA SOLICITS AEROSPACE INDUSTRY TECHNOLOGY PROGRAM PROPOSALS

NASA's Office of Advanced Concepts and Technology has issued a Cooperative Agreement Notice soliciting proposals from all sources for industry-led research and development projects under the Aerospace Industry Technology Program (AITP).

The AITP seeks strong and active involvement from industry in all aspects of the program, which aims to develop and apply advanced technology rapidly in aerospace industry applications and in the non-aerospace commercial marketplace. The solicitation seeks proposals which focus on research and development in pre-competitive technologies and novel applications which support high-risk and high-payoff opportunities with a strong potential for commercial benefits.

Proposers are encouraged to capitalize on existing technologies, tools and capabilities that have been developed for previous NASA and other aerospace programs. Leadership of proposing teams must reside with two or more U.S. for-profit organizations. Supporting participation as full team members is open to all U.S. organizations, including non-profit organizations and NASA and other federal laboratories. Foreign firms can participate as sub-contractors to full team members.

The selection process will take place in two steps. Preliminary white papers are requested of all organizations planning to submit proposals by July 1. Though requested, white papers are not required. Full proposals must be submitted by September 2. A government team will evaluate the proposals from a technical perspective. A team of predominantly non-government business specialists will be used to evaluate the proposals from a business and technology commercialization perspective. Announcement of finalists is planned by September 30 and of selected proposals by October 21.

- more -

Additional guidelines regarding the definition of what constitutes a U.S. organization for this program and for foreign participation are available in the AITP Program Information Package. Copies of the program information can be obtained by calling 1-800-225-2487, via facsimile at 202-358-3084. The information also can be obtained electronically by anonymous file transfer protocol (FTP) by accessing "ftp.oact.hq.nasa.gov" or by dialing the National Technology Transfer Center's Business Gold electronic bulletin board at 304-243-2561.

A public meeting for parties considering applying for this program will be held at 2:30 pm on Friday, June 10, in the NASA Headquarters auditorium, 300 E St., SW (west end of building), Washington, D.C. John Mankins is the AITP program manager. Fiscal Year 1994 funding for the program is $19.7 million.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Karen Hillenbrand (primary)
Lewis Research Center, Cleveland, Ohio
(Phone: 216/433-8855)

Barbara E. Selby (back-up)
Headquarters, Washington, D.C.
(Phone: 202/358-1983)

For Release
June 7, 1994

RELEASE: C94-u

CONTRACT AWARDED FOR NATIONAL WIND TUNNEL STUDIES

The National Aeronautics and Space Administration has awarded a letter contract to The Boeing Co., Commercial Airplane Group, Renton, Wash., for engineering design and trade studies in support of the National Wind Tunnel Complex (NWTC).

Under terms of the contract, Boeing, in conjunction with the other members of the industry team -- McDonnell Douglas, Lockheed, General Electric and Pratt and Whitney -- will initially be authorized to undertake Phase 1 activities through October 1994. The work includes technical trade studies, costing analyses, requirements evaluations, risk reduction studies, preliminary technical work for future site selection activities and system engineering activities.

The contract, including later optional phases for preliminary design and site-specific activities, is estimated at $60 million over 18 months. Site-specific activities will not be authorized in the later phases until appropriate consultation takes place with representatives of the Administration and Congress. The Wind Tunnel Program Office located at NASA's Lewis Research Center, Cleveland, Ohio, will manage the sole source, cost reimbursement (no fee) contract.

The work performed under the agreement will generate the necessary technical and cost information required for future programmatic decisions by the Administration as to whether to proceed with actual tunnel construction of the facility in fiscal year 1996.

The National Wind Tunnel Complex program is a joint effort between government and industry to construct state-of-the-art transonic and low-speed wind tunnels to meet the turn-of-the-century needs of the aerospace industry.

-more-

It also represents a concerted effort to find new and innovative ways consistent with the recommendations of the National Performance Review to build national dual use facilities. The new model would include shared allocation of costs and risks between industry and government and incorporation of best commercial practices throughout the project.

If approved, the proposed facility would cost between $1.8 and $2.5 billion and would address the commercial, defense and research requirements of the government and private sector.

-end-

NASA News
National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Charles Redmond
Headquarters, Washington, D.C.
(Phone: 202/358-1757)

For Release

June 7, 1994

NOTE TO EDITORS: N94-39

SMALLSAT COMPETITION WINNERS TO BE NAMED

Administrator Daniel S. Goldin will announce NASA's "new way of doing business" when he names the winning proposals in the "Smallsat" competition on Wednesday, June 8, at 1:00 p.m. EDT at a press conference in the NASA Headquarters Auditorium, 300 E St., SW, Washington, D.C.

This competition epitomizes the "faster, better, cheaper" approach to spacecraft development and highlights NASA's new leaner management style.

The Small Spacecraft Technology Initiative (SSTI) program is one of the agency's new technology initiatives and will demonstrate a new approach to design and development which significantly lowers the cost of a spacecraft. At the same time this method gives industry the flexibility to incorporate cutting-edge technology in the development process.

The solicitation sought proposals for two spacecraft to be developed, launched and serviced on-orbit for one year. The procurement also set aggressive goals for both small business and small disadvantaged business contributions to the project.

Representatives from the winning proposal teams will be available for Q&A following the announcement. Representatives from the U.S. Congress, including Rep. Robert Walker (R-PA), will be in attendance.

The press conference will be shown live on NASA Television, Spacenet 2, 69 degrees west longitude, Transponder 5 (Channel 9), frequency 3880 MHz, horizontal polarization. Q&A will be taken from NASA field centers during the press conference.

-end-

NASA News
National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 358-1600

For Release

Terri Sindelar
Headquarters, Washington, D.C.
(Phone: 202/358-1977)

June 7, 1994

RELEASE: 94-92

CHAPPELL NAMED TO WHITE HOUSE GLOBE PROJECT

Dr. Charles R. (Rick) Chappell, the Associate Director for Science at NASA's MarshaYOUNG ASTRONAUT COUNCIL 1308le, Ala., has been named by the White House to serve a one-year assignment as the Deputy Director of the Global Learning and Observations to Benefit the Environment (GLOBE) Program.

Chappell will lead NASA's participation in the GLOBE program and will serve as Special Assistant for Environmental Outreach reporting directly to the NASA Administrator. He will be assigned to the White House and together with the GLOBE Director, Thomas Pyke, Jr., will work on the design and implementation of the GLOBE program for the Vice President.

"The GLOBE program is an innovative environmental education program envisioned by the Vice President. GLOBE will offer students around the world the opportunity to become active stewards of planet Earth," said NASA Administrator Daniel S. Goldin.

"Rick Chappell is an outstanding scientist and manager, who throughout his 20 year career with NASA, has actively created education and outreach programs for the Agency," said Dr. France Cordova, NASA's Chief Scientist. "NASA is pleased to support Dr. Chappell's selection to serve on the GLOBE project."

GLOBE is an environmental education program in which students and teachers from around the world will make environmental observations in their local communities. The environmental data include observations about weather, water and air chemistry and quality, geological measurements and ecology. These measurements will be transmitted via a combination of ground and satellite networks and will be available to scientists studying global change.

These measurements collected by students worldwide can contribute to NASA's Mission to Planet Earth Program, which together with NOAA's environmental satellites, will be a principal source of data on our changing environment.

- more -

Chappell has served as the Chief Scientist for NASA's Marshall Space Flight Center. He has directed research in solar terrestrial physics where he has authored more than 100 papers on the Earth's ionosphere and magnetosphere. He has held a variety of science management positions and trained as an alternate Payload Specialist for STS-45, the Atlas-1 mission that studied the changing Sun-Earth environment. Chappell is a magna cum laude graduate in physics from Vanderbilt University with a Ph.D. in space science from Rice University.

The White House also today announced that Thomas Pyke, Jr., was named as the Director of the GLOBE program. Pyke currently is the Director of High Performance Computing and Communications for the National Oceanic and Atmospheric Administration.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 358-1600

For Release

Charles Redmond
Headquarters, Washington, D.C.
(Phone: 202/358-1757)

June 8, 1994

RELEASE: 94-94

NASA ANNOUNCES SMALLSAT CONTRACT AWARDS

NASA Administrator Daniel S. Goldin today put NASA's "faster, better, cheaper" policy into practice with the announcement of contract awards for two new "Smallsat" satellites that will observe the Earth with unprecedented sensor technology. The smallsat program will help open new commercial opportunities for American industry and contribute significantly to the science goals of NASA's Mission to Planet Earth and several other science programs.

Goldin announced two teams led by CTA of Rockville, Md., and TRW, Inc. of Redondo Beach, Calif., were chosen in an industry-led competition to build, launch and operate the satellites -- each no bigger than a console television set -- for less than $60 million each. The satellites are to be developed, launched and delivered on orbit in 24 months or less on a Pegasus launch vehicle.

"This is a new way of doing business for NASA. We told the industry what to do -- not how to do it. If the satellites don't perform, they don't get their performance fees. If they run into cost overruns, they'll face a dollar-for-dollar reduction in their fees," Goldin said.

The entire contract process -- from final announcement to contract signing -- was completed in 70 days, instead of six months to a year.

"From the beginning, industry has involved minority-owned businesses and small businesses with leading roles in this critical, high-technology enterprise," Goldin said. "This is a bold new way to do business that draws on women, minorities, students and teachers to create a richer process from the start."

"We'll be putting a new class of satellites into the sky, with unprecedented ability to scan both the countryside and the city landscape on a global scale for scientific and commercial purposes," Goldin added.

- more -

TRW's $59 million satellite will be the first-ever "hyper-spectral" imaging system, using a sensor with 384 separate spectral bands and cloud editing capability. The system will have wide applications in the Earth science activities and new commercial business opportunities in forestry, agriculture, water and land-use management, and environmental monitoring.

"The satellite is designed to tell us whether it's looking at a sugar maple or an elm -- and whether the tree is diseased or healthy. It will tell farmers when pests are invading their crops, monitor Superfund cleanup sites from space, track coastal erosion, and help high-tech prospectors search for minerals worldwide -- all far more cost-effectively and efficiently than traditional methods can do the job," Goldin said.

The CTA team proposal calls for development, construction and operation of a satellite which combines a very high resolution optical element with stereo imaging capabilities for $49 million.

"The CTA satellite is designed to locate utility pipelines and cables from the sky, help city planners evaluate their transporation needs and problems, and help developers and contractors assess construction sites," Goldin said.

Both spacecraft will carry additional instruments that will provide global atmospheric pollution dynamics information for Mission to Planet Earth. In addition, the sensors on both spacecraft also provide science data for space physics and cosmic-ray astronomy. Each of the industry teams assembled multiple science investigator teams to pursue the several science disciplines.

The agreement signed between NASA and the industry teams also commits NASA to cost accountability. Award fees will be provided to the contractors based on performance and cost overruns will come out of the contractor fees and will not be paid by the government.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 358-1600

For Release

Michael Braukus
Headquarters, Washington, D.C.
(Phone: 202/358-1979)

June 8, 1994

RELEASE: 94-95

STUDENTS SELECTED FOR NASA SCIENCE TRAINING PROGRAM

NASA has selected 38 college students for an intensive six-week Space Life Sciences Training Program (SLSTP) at its Kennedy Space Center in Fla. The summer residence training program is for undergraduate college students majoring in life sciences, bioengineering, and related science and engineering fields.

SLSTP is designed to attract college students to a career in space life sciences research, and encourages the participation of women and historically underrepresented minorities.

Selected students work with NASA researchers in developing flight and ground-based space life sciences experiments. In addition to offering hands-on research experience, the curriculum utilizes lectures by astronauts, as well as NASA and university scientists, facility tours and special projects to provide a complete overview of the field of space life sciences.

The special project areas this year will involve plant space biology, flight experiment development, ecological monitoring and controlled ecological life support systems. The program will be held from mid-June through the end of July.

After the successful completion of the program, five semester hours of college credit will be offered to each student through Florida A&M University.

The 38 students were selected competitively from nearly 400 applicants. Students in the program must be undergraduates majoring in science or engineering and have a minimum cumulative grade point average of 3.0/4.0. More than 325 students have participated in the program since its inception in 1985.

- more -

SLSTP is sponsored by NASA's Office of Life and Microgravity Sciences and Applications and by the Minority University Research and Education Division.

The students selected for the 1994 Space Life Sciences Training Program are:

Student Hometown	College	
Baez, Benjamin O.	Wallace, Calif.	Ohlone College, Calif.
Barbour, Dennis L.	Glasgow, Ky.	Georgia Tech.
Capellan, Irene W.	Beaverton, Oregon	U. of Portland
Carlson, Derek D.	Reno, Nev.	U. of Nevada
Chan, Audrey S.Y.	Brockport, N.Y.	S. U. N. Y. at Buffalo
Copp, Hillary L.	Oakdale, Calif.	U.C. Santa Barbara
Couture, Allen S.	Tampa, Fla.	Jacksonville U.
Evonich, Rudy F.	Manistique, Mich.	Alma College, Mich.
French, Amy E.	Greensboro, N.C.	U. of North Carolina
Friday, Bridgette N.	Missouri City, Texas	Texas Southern U.
Gaston, Eva V.	Oklahoma City, Okla.	Spelman College, Ga.
Gifford, Kari. L.	Laingsburg, Mich.	Alma College, Mich.
Gillam, Tonya R.	Kokomo, Ind.	Indiana U.
Gonzalez-Velez,	Juan M. Trujillo Alto,	P.R. U. of Puerto Rico
Goodyear, Amy L.	West Kingstown, R.I.	Rhode Island College
Huang, Howard	Sugarland, Texas	U. of Texas at Austin
Hunter, Tiffeny D.	Palatka, Fla.	Florida A&M U.
Israel, Adina	Chicago, Ill.	U. of Southern Calif.
Joiner, Nikki	Eastman, Ga.	Berry College, Ga.
King, Bryan R.	New Orleans, La.	Xavier U., La.
Leigh, Mary B.	Norman, Okla.	U. of Okla.
Matthews, Rebecca E.	East Amherst, N.Y.	S. U. N. Y. at Buffalo
May, Jennifer L.	West Milford, N.J.	Cornell U.
McLachlan, Douglas I.	Redwood City, Calif.	Morehouse College, Ga.
Murray, Anika S.	Upper Marlboro, Md.	Florida A & M
Oklu, Rahmi	Sunnyside, N.Y.	S. U. N. Y. at Buffalo
Parker, Khary	Norristown, Pa.	Tuskegee Institute,Al.
Parker, Reggie J.	Brooklyn, N.Y.	Brooklyn College
Raychaudhuri, Soumya	Rochester, N.Y.	S. U. N. Y. at Buffalo
Rodriguez, Ileana M.	Hialeah, Fla.	Fla. International U.
Starwalt, Ronald D.	Anderson, S.C.	Tri-county Technical College, S.C.
Strauchs, Tiffany Y.	Great Falls, Va.	St. John's College,
Md. Swain, Tomi L.	St. Martinville, La.	Southern U., La.
Thomas, Mary E.	San Antonio, Texas	Texas A & M
Walker, Joseph C. II	Centerville, Iowa	Central College, Iowa
Walker, Kendra L.	Jackson, Miss.	Dillard U., La.
Washburn, Meika R.	Columbia, S.C.	North Carolina A & T State U.
Willis, Latasha A.	Jackson, Miss.	Tougaloo College,Miss.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

For Release

Laurie Boeder
Headquarters, Washington, D.C.
(Phone: 202/358-1898)

June 9, 1994

STATEMENT BY NASA ADMINISTRATOR DANIEL S. GOLDIN

Response to markup of NASA Budget by House Appropriations Subcommittee on VA-HUD-Independent Agencies

"Given the enormous challenge that Chairman Stokes and the members of his committee had in adequately addressing the many needs of the agencies covered in this budget, NASA is pleased with today's markup.

"NASA has stepped up to the budget challenge, and adopted a lean management approach to meet the President's mandate to do more with less. Over the last 18 months we've cut billions from the NASA budget, and we're pleased to comply with the further challenge Mr. Stokes has presented in today's markup. We want to be part of the solution, not part of the problem.

"We've worked with The Office of Management and Budget and the other agencies to pare out budgets, satisfy the tough goals set by Congress, and keep the President's budget priorities intact. In the weeks ahead, we will continue to work with Chairman Stokes and his committee as we proceed with the difficult task of accommodating competing priorities within the allocation."

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Sarah Keegan
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Jim Elliott
Goddard Space Flight Center, Greenbelt. Md.
(Phone 301/286-6256)

For Release
June 9, 1994

NOTE TO EDITORS: N94-40

HUBBLE BRIEFING ON PROTOPLANETARY DISKS

New Hubble Space Telescope (HST) pictures of protoplanetary disks in a cluster of young stars will be the subjects of a media briefing Monday, June 13, 1994, at 2:00 p.m. EDT in the NASA Headquarters auditorium, 300 E Street, SW, Washington, D.C.

Presenting the images and his findings will be Dr. C. Robert O'Dell, professor of astrophysics at Rice University in Houston. Moderator Dr. Stephen Maran, NASA's Goddard Space Flight Center, will be joined by Dr. Anne Kinney, astronomer, Space Telescope Science Institute, Baltimore, Md., and Dr. Suzan Edwards, professor of astronomy at Smith College, in a discussion of the significance of these findings.

Copies of the new HST images will be available at the briefing. Immediately before and after the briefing, there will be a clean video feed of the graphics used in the program.

This event will be carried live on NASA Television, Spacenet 2, 69 degrees west longitude, Transponder 5 (Channel 9), frequency 3880 MHz.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Sonja A. Maclin
Washington, D.C. 20546
(Phone: 202/358-1600)

Larry Velez
Health and Human Services
Washington, D.C. 20201
(Phone: 202/619-3197)

For Release
June 14, 1994

MEDIA ADVISORY

NASA AND HHS HONOR 30TH ANNIVERSARY OF CIVIL RIGHTS BILL

Rosa Parks, the Honorable Floyd H. Flake (D.NY) and Rev. Walter Fauntroy and James Farmer will join NASA Administrator Daniel S. Goldin, the Department of Health and Human Services Deputy Secretary Dr. Walter Broadnax and a host of local and national civil rights dignitaries and organizations at a ceremony to commemorate the 30th anniversary of the signing of the Civil Rights Act.

The ceremony will take place on June 15, 1994, at 6:00 p.m. EDT in the Great Hall of the Hubert Humphrey Building, 200 Independence Ave., SW, Washington, D.C.

Invitees include Coretta Scott King, Rev. Jesse Jackson, members of the Congressional Black and Hispanic Caucuses and federal agency cabinet heads.

The ceremony will recognize those who contributed to the passing and implementation of the civil rights legislation, pay tribute to the unsung heroes of the civil rights movement and reflect on what the movement meant then, now and the impact the movement will have on our nation's future generation.

"NASA's commitment to civil rights will set the Equal Opportunity Standard for Excellence in the 21st century through a highly skilled workforce which is representative at all levels of America's diversity. A workforce that is built upon trust, respect, teamwork, empowerment and commitment to an environment which fosters equality in all of NASA's endeavors", said Associate Administrator for Equal Opportunity Programs, Dr. Yvonne Freeman.

Participating in the ceremony will be the Tuskegee Airmen as NASA honors those men known as the "Civil Rights Movement of the Armed Services of World War II." Master of Ceremonies will be Col. Guy Bluford, the first African-American astronaut in space.

-more-

Providing the keynote address will be Rev. Fred L. Shuttlesworth, Pastor, Greater New Light Baptist Church, Cincinnati, Ohio. Shuttlesworth was one of the primary coordinators of the civil rights movement and one of the five organizers of the Southern Christian Leadership Conference (SCLC).

-end-

NASA News
National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Drucella Andersen
Headquarters, Washington, D.C.
(Phone: 202/358-4733)

For Release
June 15, 1994

Kirsten Williams
Langley Research Center, Hampton, Va.
(Phone: 804/864-6527)

RELEASE: C94-v

NASA SELECTS HONEYWELL FOR $75 MILLION AERO CONTRACT

NASA has selected a team led by Honeywell Inc., for an award of a $75 million, cost-reimbursement contract, including options, for the development of flight deck technologies in support of the agency's High Speed Research program.

The work, to be managed by NASA's Langley Research Center, Hampton, Va., will be conducted over eight-years and will take place at the contractor's plants in Minneapolis, Minn., and Phoenix, Ariz., and at selected sub-contractor locations.

Honeywell will support the development of technologies for advanced sensors and computer systems, guidance and control system concepts, and a next-generation flight deck design for a potential future High Speed Civil Transport. This supersonic commercial aircraft could fly 300 passengers across the Pacific or Atlantic Oceans at 2.4 times the speed of sound -- cutting travel time by more than half.

Synthetic forward visibility systems will be designed, developed and tested to allow a flight crew to operate in the absence of forward windows and in poor visibility conditions. The technologies also could provide greater route flexibility and decrease fuel consumption while increasing efficiency and safety. Researchers plan to integrate flight deck technologies within the cockpit and with the rest of the airframe and propulsion systems.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Donald L. Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release
June 15, 1994

NOTE TO EDITORS: N94-43

MARS OBSERVER CORRECTIVE ACTION PLAN AVAILABLE

NASA today released the Mars Observer Corrective Action Plan, an evaluation of the Mars Observer failure review efforts. The Corrective Action Plan is designed to identify lessons learned and determine specific actions to be taken by the Agency to prevent failures such as the Mars Observer in the future.

The 257-page Mars Observer Corrective Action Plan is available to news media representatives by faxing your request to the NASA Newsroom at 202/358-4210 or 358-4335. A five-page executive summary is also available.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Steve Nesbitt
Johnson Space Center, Houston
(Phone: 713-483-5111)

For Release

June 16, 1994

RELEASE: 94-036

HUNTOON ANNOUNCES CENTER REORGANIZATION

Organizational changes that will help NASA meet its Space Shuttle and Space Station goals, and position the Johnson Space Center for the future were announced today by Center Director Dr. Carolyn L. Huntoon.

"Since becoming Director in January, I have given a great deal of thought to how we can best organize to deal with the challenges and the opportunities that lie ahead. Our current structure and business practices have served us well in the past. However, I believe this new organization, combined with new ways of doing business, will position us well for the future."

In an announcement to employees, Huntoon said the challenge to assure the success of the Shuttle and International Space Station programs in light of reduced budgets provides the basic framework for change.

"Faced with unprecedented challenges in the form of diminishing resources and the need to effectively support two major programs, we must find ways to take greater advantage of the unique combination of expertise in engineering, science and operations at this center," said Huntoon. "We currently enjoy the greatest level of public support in recent years, and we must deliver on that support. These changes will help us do that."

The changes are designed to streamline and strengthen support to projects and programs, strengthen core technical capabilities, improve business practices, and place greater emphasis on partnerships and teaming arrangements with industry, academia, and other government agencies.

Key in the reorganization is a new Projects Office which has been established to bring a greater focus to projects and efforts which support the major programs by effectively teaming the science, technical and engineering strengths of the Center's workforce.

-more-

In a move to further strengthen the Center's core technical capabilities, a number of key functions will be shifted and realigned among the larger technical organizations for greater efficiency and depth of talent.

To streamline and improve business management and institutional support functions at the center, a new business management organization will be created to carry out basic change in the way budget, procurement, and financial support is provided to the key organizations. Center information systems and processes will be reorganized to support the new business approach.

Huntoon also announced a number of planned cultural changes intended to promote and develop teamwork, experience, and diversity in the activities of the center. Rotational assignments will be encouraged as a means to broaden the knowledge and experience of employees and to develop leaders for the future.

The concept of "teaming" will be employed with groups of experts from one organization located in others where their services are utilized. Managers will be challenged to take active roles in forming partnerships and teaming arrangements with industry, academia, and other government agencies.

A number of key leadership changes were also announced. "There is a great deal of talent at JSC which affords me the opportunity to make several key appointments that will contribute to the diversity of our management team and energize the process of change," said Huntoon.

The new Projects Office will be headed by Larry Bourgeois, a former Space Shuttle flight director who is currently the assistant director of Mission Operations for the Space Station program. Within the Projects Office, a new office headed by astronaut Frank Culbertson will be responsible for JSC's project support to the joint Shuttle-Mir activities with Russia's space agency.

Terrence Hesse, former assistant director of the Houston district office of the Internal Revenue Service, will become the director of the new Business Management Directorate. Jane Stearns, currently deputy director of the Shuttle Program Office's Management Integration Office, will be the new director of the Information Systems Directorate (ISD).

Jack Garman, formerly deputy director of ISD, will fill the newly-created position of Chief Information Officer, reporting to the Center Director. In that role, he will establish common standards and practices in the use and development of information systems at JSC.

John O'Neill has been named as director of Mission Operations and Astronaut Tom Akers has been detailed to the organization as deputy director. Astronaut Steve Nagel will be detailed as deputy director of Safety, Reliability, and Quality Assurance.

-more-

James Hickmon will head the Center Operations Directorate (COD), and Richard Thorson will join him as deputy director. Grady McCright, the current COD director, will become Manager of JSC's White Sands Test Facility in New Mexico.

Director of Public Affairs, Harold Stall will join Huntoon's staff as special assistant for Community Relations and Special Projects. In this role, he will undertake a new effort to identify areas of common interest between JSC and the greater Houston community, and develop plans for new cooperative ventures in these areas. Jeffrey Carr, currently chief of the News and Information Branch, will serve as acting director of Public Affairs.

Estella Gillette will serve as acting director of Equal Opportunity Programs, replacing Dr. Joseph Atkinson who will join the Office of Public Affairs to take on a new role designed to strengthen JSC's ties to minority educational institutions across the country.

"Together with our reorganization," Huntoon said, "these changes to our culture and leadership will help ensure that we are in the best possible position to fulfill our responsibilities, and provide a challenging and rewarding work environment for our people."

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Laurie Boeder
Headquarters, Washington, D.C.
(Phone: 202/358-1898)

For Release

June 17, 1994

NOTE TO EDITORS: N94-42

NASA ADMINISTRATOR TO GIVE MAJOR SPACE STATION POLICY SPEECH

NASA Administrator Daniel S. Goldin will give a major policy speech on the International Space Station and the future of the Nation's space program on Monday, June 20, 1994, at 1:00 p.m. EDT, at the National Press Club, 14th and F Streets, N. W., Washington, D.C.

The speech will be Goldin's first major statement following the Congressional markup of NASA's 1995 budget and the recent announcement of contracts for small satellites to officially begin NASA's new way of doing business for the American taxpayer.

Goldin will speak for 20-25 minutes followed by a 30-minute question and answer period from the Press Club audience. For ticket information or details concerning the luncheon that will take place prior to the speech, call Sherry Burton at (202) 662-7501.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Charles Redmond
Headquarters, Washington, D.C.
(Phone: 202/358-1757)

For Release

June 17, 1994

NOTE TO EDITORS: N94-44

HUMAN ASSISTANT ROBOT ON DISPLAY AT NASA HQ

A robot nicknamed "Charlotte" designed to assist astronauts in orbiting laboratories, will be demonstrated in the West Lobby of the NASA Headquarters Bldg., 300 E St., SW, Washington, DC, the week of July 20. The robot was designed, engineered, and built by McDonnell Douglas Aerospace as part of the company's on-going human spaceflight engineering and integration activities.

Charlotte™, named after the spider in "Charlotte's Web," is a breadbox-sized assistant designed to help astronauts in orbiting laboratories such as the Spacehab. McDonnell Douglas used internal company funds to develop the Charlotte™ robot.

The reference to Charlotte's Web stems from the robot's design, which uses a series of wires set in place in front of equipment racks, along which the robot moves. Charlotte™ has a "hand" which can be programmed to perform switch manipulations, turn open valves, and execute other required but often tedious tasks which might otherwise take valuable crew time to perform.

The assistant is also designed to place minimal additional demands on space vehicle power. The required set-up time also has been minimized. Standard laboratory programming languages have been used to enable a multitude of research disciplines to use the robot. Charlotte™ can perform programs which are loaded by astronauts or from experiments on the ground. This versatility will provide additional opportunities for on-orbit experiment activities, including those which might occur during extended periods.

-more-

The Charlotte™ robot will be in the NASA lobby Monday through Friday from 9 am to 3 pm for media wishing to either observe pre-programmed activities or engage in operating the robot themselves. Literature on the development activities and potential uses for the Charlotte™ robot both in space and here on Earth will also be available.

Pat Swaim and Clark Thompson, both McDonnell Douglas Aerospace, Houston, will be the technical experts on hand to provide demonstrations. Other McDonnell Douglas elements, including those located in Huntsville, Ala., at the Spacehab Payload Processing Facility, Port Canaveral, Fla., and Huntington Beach, Calif., were also involved in the Charlotte™ robot development activities.

-end-

94-96

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION

STS-65

PRESS KIT
JULY 1994

INTERNATIONAL MICROGRAVITY LABORATORY-2 (IML-2)

PUBLIC AFFAIRS CONTACTS

For Information on the Space Shuttle

Ed Campion Headquarters, Wash., D.C.	Policy/Management	202/358-1778
James Hartsfield Johnson Space Center, Houston	Mission Operations Astronauts	713/483-5111
Bruce Buckingham Kennedy Space Center, Fla.	Launch Processing KSC Landing Information	407/867-2468
June Malone Marshall Space Flight Center, Huntsville, Ala.	External Tank/SRBs/SSMEs	205/544-0034
Don Haley Dryden Flight Research Center, Edwards, Calif.	DFRC Landing Information	805/258-3448

For Information on NASA-Sponsored STS-65 Experiments

Mike Braukus Headquarters, Wash., D.C.	IML-2 Payloads	202/358-1979
Debra Rahn Headquarters, Wash., D.C.	International Cooperation	202/358-1639
Charles Redmond Headquarters, Wash., D.C.	CPCG	202/358-1757
Terri Sindelar Headquarters, Wash., D.C.	SAREX-II	202/358-1977

For Information on DOD-Sponsored STS-65 Experiments

Dave Hess Johnson Space Center, Houston	AMOS, MAST	713/483-3498

CONTENTS

GENERAL BACKGROUND

General Release 3
Media Services Information 5
Quick-Look Facts 6
Shuttle Abort Modes 8
Summary Timeline 9
Payload and Vehicle Weights 10
Orbital Events Summary 10
Crew Responsibilities 11

CARGO BAY PAYLOADS & ACTIVITIES

International Microgravity Laboratory-2 (IML-2) 13
Orbital Acceleration Research Experiment (OARE) 117

IN-CABIN PAYLOADS

Commercial Protein Crystal Growth (CPCG) 118
Air Force Maui Optical Site (AMOS) 119
Military Applications of Ship Tracks (MAST) 119
Shuttle Amateur Radio EXperiment 120

STS-65 CREW BIOGRAPHIES

Robert D. Cabana (Commander) 122
James Donald Halsell (Pilot) 122
Richard J. Hieb (Mission Specialist-1) 123
Carl E. Walz (Mission Specialist-2) 123
Leroy Chiao (Mission Specialist-3) 123
Donald A. Thomas (Mission Specialist-4) 124
Chiaki Naito-Mukai (Payload Specialist-1) 124

SPACE SHUTTLE PROGRAM INFORMATION

Statistical Study of Space Shuttle Productivity 126
IML-2 Module Rack 128
Previous Space Shuttle Missions 129
Upcoming Space Shuttle Flights 130

Release: 94-96

INTERNATIONAL MICROGRAVITY LABORATORY MAKES SECOND FLIGHT

Shuttle Mission STS-65 will see Space Shuttle Columbia and her seven-person crew conduct the second flight of the International Microgravity Laboratory-2 (IML-2), a payload that involves a world-wide research effort into the behavior of materials and life in the weightless environment of Earth-orbit.

The STS-65 crew will use furnaces and other facilities to produce a variety of material structures, from crystals to metal alloys. From the experiments conducted, scientists will be able to examine subtle forces which affect material development in microgravity. Investigators also will be able to study fluid processes that are masked or distorted on Earth. This knowledge may help us develop the next generation of materials needed for high-tech applications and lead to refinement of materials such as semiconductors, superconductors, and exotic ceramics and glasses.

The life science experiments conducted during IML-2 will help reveal the role of gravity in shaping life as we know it and show us how living organisms react and adapt to microgravity. The reduced gravity encountered in space allows certain characteristics of cells and organisms to be studied using innovative laboratory hardware and techniques. Insights scientists gain about life in space can increase knowledge of the factors which govern life and health on Earth.

Scientists from NASA, the European Space Agency (ESA), the French Space Agency (CNES), the German Space Agency (DARA), the Canadian Space Agency (CSA) and the National Space Development Agency of Japan (NASDA) have cooperated in planning experiments which will be performed during the STS-65 mission. More than 200 scientists developed over 80 investigations for the IML-2 mission.

Leading the STS-65 crew will be Mission Commander Robert D. Cabana who will be making his third flight. Pilot for the mission is James Donald Halsell, Jr. who is making his first flight. The four mission specialists aboard Columbia are Richard J. Hieb, the STS-65 Payload Commander, who will be making his third flight; Carl E. Walz who will be making his second flight; Leroy Chiao, who will be making his first flight; and Donald A. Thomas who will be making his first flight. Chiaki Naito-Mukai from the National Space Development Agency of Japan will serve as a payload specialist for the STS-65 mission and will be making her first flight.

-more-

Launch of Columbia currently is scheduled for no earlier than July 8, 1994, at 1:11 p.m. EDT. The planned mission duration is 13 days, 17 hours, 56 minutes. An on-time launch on July 8 would produce a landing at 7:07 a.m. EDT on July 22, 1994, at the Kennedy Space Center's Shuttle Landing Facility.

The Commercial Protein Crystal Growth payload, sponsored by the Office of Advanced Concepts and Technology (OACT), will be making its fifth flight on STS-65, using the Commercial Refrigerator/Incubator Module (CRIM) in the Shuttle middeck. This complement of experiments contains 60 different samples focusing on six proteins in various formulations to enhance the probabilities for successful results.

Two Department of Defense-sponsored experiments will be flown during the STS-65 mission. The Air Force Maui Optical System (AMOS) is an electrical-optical facility on the Hawaiian island of Maui. The AMOS facility tracks the orbiter as it flies over the area and records signatures from thruster firings, water dumps or the phenomena of "shuttle glow." The information obtained by AMOS is used to calibrate the infrared and optical sensors at the facility. The Military Applications of Ship Tracks (MAST) experiment on STS-65 is part of a five-year research program to examine the effects of ships on the marine environment. The objective of MAST is to determine how pollutants generated by ships modify the reflective properties of clouds. MAST will help in understanding the effects of man-made aerosols on clouds and the resulting impact on the climate system.

The STS-65 crew will take on the role of teacher as they educate students in the United States and other countries about STS-65 mission objectives. Using the Shuttle Amateur Radio Experiment-II (SAREX-II), astronauts aboard Columbia will discuss with students what it is like to live and work in space.

STS-65 will be the 17th flight of Space Shuttle Columbia and the 63rd flight of the Space Shuttle system.

- end -

MEDIA SERVICES INFORMATION

NASA Television Transmission

NASA television is now available through a new satellite system. NASA programming can now be accessed on Spacenet-2, Transponder 5, located at 69 degrees west longitude; frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, Fla; Marshall Space Flight Center, Huntsville, Ala.; Dryden Flight Research Center, Edwards, Calif.; Johnson Space Center, Houston and NASA Headquarters, Washington, D.C. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is provided daily at noon EDT.

Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter.

Briefings

A mission press briefing schedule will be issued prior to launch. During the mission, status briefings by a Flight Director or Mission Operations representative, and when appropriate, representatives from the payload team, will occur at least once per day. The updated NASA television schedule will indicate when mission briefings are planned.

STS-65 Quick Look

Launch Date/Site:	July 8, 1994/Kennedy Space Center - Pad 39A
Launch Time:	1:11 p.m. EDT
Orbiter:	Columbia (OV-102) - 17th Flight
Orbit/Inclination:	160 nautical miles/28.45 degrees
Mission Duration:	13 days, 17 hours, 56 minutes
Landing TIme/Date:	7:07 a.m. EDT July 22, 1994
Primary Landing Site:	Kennedy Space Center, Fla.
Abort Landing Sites:	Return to Launch Site - KSC, Fla. TransAtlantic Abort Landing - Banjul, The Gambia; Ben Guerir, Morocco; and Moron, Spain Abort Once Around - Edwards AFB, CA
STS-65 Crew:	Robert Cabana, Commander (CDR) Jim Halsell, Pilot (PLT) Rick Hieb, Payload Commander (MS1) Carl Walz, Mission Specialist 2 (MS2) Leroy Chiao, Mission Specialist 3 (MS3) Don Thomas, Mission Specialist 4 (MS4) Chiaki Mukai, Payload Specialist 1 (PS1) Red shift: Cabana, Halsell, Hieb, Mukai Blue shift: Chiao, Thomas, Walz
Cargo Bay Payloads:	International Microgravity Lab-2 (IML-2)
Middeck Payloads:	Commercial Protein Crystal Growth (CPCG) Shuttle Amateur Radio Experiment-II (SAREX-II) Orbiter Acceleration Research Experiment (OARE) Military Applications of Ship Tracks (MAST)
Other:	Air Force Maui Optical Site (AMOS)

Detailed Test Objectives/Detailed Supplementary Objectives:

DTO 251: Entry Aerodynamic Control Surfaces Test
DTO 301D: Ascent Structural Capability Evaluation
DTO 307D: Entry Structural Capability Evaluation
DTO 312: External Tank Thermal Protection System Performance
DTO 319D: Orbiter/Payload Acceleration and Acoustics Environment Data
DTO 414: Auxiliary Power Unit Shutdown Test
DTO 623: Cabin Air Monitoring
DTO 655: Foot Restraint Evaluation
DTO 663: Acoustic Noise Dosimeter Data
DTO 665: Acoustic Noise Sound Level Data
DTO 667: Portable In-Flight Landing Operations Trainer
DTO 674: Thermo-Electric Liquid Cooling System Evaluation
DTO 805: Crosswind Landing Performance

Detailed Test Objectives/Detailed Supplementary Objectives (cont'd)
DTO 913: Microgravity Measurement Device
DSO 314: Acceleration Data Collection
DSO 326: Window Impact Observations
DSO 484: Assessment of Circadian Shifting in Astronauts by Bright Light
DSO 485: Inter Mars TEPC
DSO 487: Immunological Assessment of Crewmembers
DSO 491: Characterization of Microbial Transfer Among Crewmembers During Space Flight
DSO 603B: Orthostatic Function During Entry, Landing and Egress
DSO 604: Visual-Vestibular Integration as a Function of Adaptation
DSO 605: Postural Equilibrium Control During Landing/Egress
DSO 608: Effects of Space Flight on Aerobic and Anaerobic Metabolism During Exercise
DSO 610: In-Flight Assessment of Renal Stone Risk
DSO 614: The Effect of Prolonged Space Flight on Head and Gaze Stability During Locomotion
DSO 621: In-Flight Use of Florinef to Improve Orthostatic Intolerance Postflight
DSO 626: Cardiovascular and Cerebrovascular Responses to Standing Before and After Space Flight
DSO 901: Documentary Television
DSO 902: Documentary Motion Picture Photography
DSO 903: Documentary Still Photography

SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter and its payload. Abort modes include:

* Abort-To-Orbit (ATO) -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.

* Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit around before landing at Edwards Air Force Base, Calif.

* TransAtlantic Abort Landing (TAL) -- Loss of one or more main engines midway through powered flight would force a landing at either Banjul, The Gambia; Ben Guerir, Morocco; or Moron, Spain.

* Return-To-Launch-Site (RTLS) -- Early shutdown of one or more engines, and without enough energy to reach Banjul, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

STS-65 contingency landing sites are the Kennedy Space Center, Edwards Air Force Base, Banjul, Ben Guerir and Moron.

STS-65 Summary Timeline

Flight Day One
Ascent
OMS-2 burn (163 n.m. x 160 n.m.)
IML-2 activation/operations

Blue Flight Days Two-Thirteen
IML-2 operations

Red Flight Days Two-Thirteen
IML-2 operations

Blue Flight Day Fourteen
IML-2 operations

Red Flight Day Fourteen
Flight Control Systems Checkout
Lower Body Negative Pressure Device

Blue/Red Flight Day Fifteen
Cabin stow
Payload deactivation
IML-2 deactivation
Deorbit
Entry
Landing

STS-65 VEHICLE AND PAYLOAD WEIGHTS

Vehicle/Payload	Pounds
Orbiter (Columbia) empty and 3 SSMEs	181,443
International Microgravity Lab-2	21,187
Commercial Protein Crystal Growth	58
Orbiter Acceleration Research Experiment	249
Shuttle Amateur Radio Experiment-II	37
Military Applications of Ship Tracks	66
Detailed Supplementary/Test Objectives	205
Total Vehicle at SRB Ignition	4,522,321
Orbiter Landing Weight	228,640

STS-65 ORBITAL EVENTS SUMMARY

EVENT	START TIME (dd/hh:mm:ss)	VELOCITY CHANGE (feet per second)	ORBIT (n.m.)
OMS-2	00/00:42:00	221 fps	163 x 160
Deorbit	13/16:56:00	270 fps	N/A
Touchdown	13/17:56:00	N/A	N/A

STS-65 CREW RESPONSIBILITIES

TASK/PAYLOAD	PRIMARY	BACKUPS/OTHERS
IML-2	Hieb	
Middeck Payloads:		
SAREX	Cabana	Thomas
CPCG	Cabana	Walz
MAST	Walz	Cabana
OARE	Thomas	Walz, Halsell
Detailed Test Objectives:		
DTO 312	Thomas	Chiao
DTO 414	Halsell	Walz
DTO 623	Walz	Halsell
DTO 655	Chiao	Hieb
DTO 663	Cabana	Walz
DTO 665	Cabana	Walz
DTO 667	Cabana	Halsell
DTO 805	Cabana	Halsell
Detailed Supplementary Objectives:		
DSO 314	Halsell	Walz
DSO 485	Cabana	Walz
Other:		
Photography/TV	Halsell	Walz
In-Flight Maintenance	Walz	Halsell
EVA	Chiao (EV1)	Thomas (EV2), Walz (IV)
Earth Observations	Halsell	Cabana
Medical	Cabana	Walz

IML -2 PAYLOADS: CREW ASSIGNMENTS

PAYLOAD	PRIMARY	BACKUPS/OTHERS
AAEU	Thomas	Mukai, Chiao, Hieb
APCF	Chiao	Hieb, Thomas, Mukai
BDPU	Thomas	Mukai, Chiao, Hieb
Biorack	Chiao	Hieb, Thomas, Mukai
CPF	Chiao	Hieb, Thomas, Mukai, Cabana
EDOMP	Mukai	Hieb, Thomas, Chiao
FFEU	Mukai	Thomas, Hieb, Chiao
LIF	Mukai	Thomas, Hieb, Chiao
NIZEMI	Chiao	Hieb, Thomas, Mukai
PAWS	Cabana	Halsell, Walz
QSAM	Thomas	Mukai, Chiao, Hieb
RAMSES	Thomas	Mukai, Chiao, Hieb
RRMD	Mukai	Thomas, Hieb, Chiao
SAMS	Thomas	Mukai, Chiao, Hieb
SCM	Hieb	Mukai
TEI/CCK	Mukai	Thomas, Hieb, Chiao
TEMPUS	Thomas	Mukai, Chiao, Hieb

IML-2: THE SECOND INTERNATIONAL MICROGRAVITY LABORATORY

The second International Microgravity Laboratory Spacelab mission brings together scientists from around the world in a search for answers which might only be found in the unique laboratory of space.

As the Shuttle orbits Earth, it provides a nearly weightless, or microgravity, environment. Microgravity cannot be duplicated for longer than a few seconds with Earth-based facilities. The IML-2 mission objective is to conduct microgravity and life sciences research that can only be accomplished in this low-gravity environment.

In a space laboratory, some of the physical processes which affect experiments on Earth are not as dominant. Gravity-related disturbances such as buoyancy, sedimentation and hydrostatic pressure cannot only limit the quality of some materials but also limit the ways materials can be studied.

IML-2 scientists will use furnaces and other facilities to produce a variety of material structures, from crystals to metal alloys. They will examine subtle forces which affect material development in microgravity. Scientists also will be able to study fluid processes that are masked or distorted on Earth. Nearly every physical science depends on an understanding of these basic mechanisms. This knowledge may help us develop the next generation of materials needed for high-tech applications and lead to refinement of materials such as semiconductors, superconductors, and exotic ceramics and glasses.

Life science research on IML-2 will help reveal the role of gravity in shaping life as we know it and show us how living organisms react and adapt to microgravity. Before we can make space our second home, we must understand how living things are affected by reduced gravity and radiation in the space environment. Insights scientists gain about life in space can increase knowledge of the factors which govern life and health on Earth.

For instance, previous space flights have demonstrated that high quality protein crystals, suitable for X-ray analysis, can be grown in space. If the structures of certain proteins can be determined by examining these crystals, not only will we learn about an essential component of all life forms, but we could use this knowledge to improve the medical treatment of many diseases.

IML-2 Science

More than 200 scientists from six space agencies developed over 80 investigations for the IML-2 mission. Representatives of the European Space Agency (ESA), the French Space Agency (CNES), the German Space Agency (DARA), the Canadian Space Agency (CSA) and the National Space Development Agency of Japan (NASDA) are joining NASA in this mission of discovery.

An international crew will conduct these experiments inside Spacelab, a versatile research laboratory which fits in the Space Shuttle cargo bay. It is an appropriate place for multi-national research, since Spacelab was developed by the ESA in the late 1970s and early 1980s as its contribution to the American Space Shuttle Program. IML-2 uses the pressurized Spacelab module. With its extra work area, power supplies, data management capability and versatile equipment racks, scientists in space can work much as they would in their laboratories on Earth.

Many IML-2 experiments owe their heritage to earlier Skylab, sounding rocket and ground-based experiments. Some have evolved over several Spacelab missions. Facilities flown on previous flights are being flown again to probe new scientific questions or to expand on prior studies. This mission also will introduce some new experiment facilities, designed to give scientists additional tools for finding answers in the microgravity of space.

MATERIALS SCIENCE: NASDA's **Large Isothermal Furnace** melts and uniformly mixes compounds, then cools them to produce a solid sample. The **Electromagnetic Containerless Processing Facility** from Germany positions metal alloys so they do not touch container walls and melts them in an ultra-pure environment. The facility records information on the alloys as they solidify.

FLUID SCIENCE: The European Space Agency's **Bubble, Drop and Particle Unit** contains special optical diagnostics, cameras and sensors for studying fluid behavior in microgravity. Their **Critical Point Facility**, which flew on IML-1, investigates fluids as they undergo critical phase transitions from liquids to gases.

MICROGRAVITY ENVIRONMENT AND COUNTERMEASURE: NASA's **Space Acceleration Measurement System**, on its tenth flight, will be joined on IML-2 by the German Space Agency's **Quasi-Steady Acceleration Measurement** experiment. Together, they will give scientists the most complete picture yet of the subtle motions which can disturb sensitive microgravity experiments. Japan's **Vibration Isolation Box Experiment System** will test a special material designed to reduce the effect of those accelerations.

BIOPROCESSING: ESA's **Advanced Protein Crystallization Facility** will provide a versatile environment for growing a variety of protein crystals using three different techniques. A video recording device will allow scientists to study the crystal growth process after the mission. Two experiment facilities, **Applied Research on Separation Methods Using Space Electrophoresis** from France and the **Free Flow Electrophoresis Unit** from Japan, will use electric fields to separate biological materials into their individual components. The process is widely used on Earth to produce ultra-pure products for pharmaceutical drugs.

SPACE BIOLOGY: Two space biology facilities from the 1992 Japanese Spacelab-J mission will fly on IML-2. Scientists will study the spawning, fertilization, embryology and behavior of newts and fish housed in the **Aquatic Animal Experiment Unit**. The **Thermoelectric Incubator/Cell Culture Kit** will accommodate the study of plant and animal cells. IML-2 will be the third flight for the European Space Agency's **Biorack**, which supports investigations into the effects of microgravity and cosmic radiation on cells, tissues, plants, bacteria, small animals and other biological samples. The **Slow Rotating Centrifuge Microscope** from Germany contains equipment for observing the movement and behavior of one-celled and multi-cellular organisms at various gravity levels. Materials scientists will take advantage of its capabilities to observe the solidification of a transparent model alloy as well.

HUMAN PHYSIOLOGY: Canada's **Spinal Changes in Microgravity** experiment, an expanded version of an IML-1 investigation, will use stereophotographs and special ultrasound and monitoring equipment to record changes in crew members' spinal and neurosensory systems. NASA's **Extended Duration Orbiter Medical Project** will continue investigations designed to maintain and evaluate crew health and safety on long-duration Shuttle flights. The crew will use the **Performance Assessment Workstation**, a laptop computer, to help determine their mental ability to perform operational tasks during long-duration missions.

RADIATION BIOLOGY: Germany's **Biostack**, a veteran of three Spacelab missions, sandwiches biological specimens between radiation detectors in a sealed container to determine how cosmic radiation affects them. Japan's **Real-Time Radiation Monitoring Device** will test methods which may be used for space radiation forecasting aboard future spacecraft.

Mission Operations

The Marshall Space Flight Center in Huntsville, Ala., manages IML-2 for NASA's Office of Life and Microgravity Science and Applications, Washington, D.C. Experiment operations for the 14-day flight will be directed from the agency's Spacelab Mission Operations Control facility at Marshall.

During the mission, hundreds of scientists and engineers representing the many IML-2 experiments will work in the Science Operations Area. From there, they can monitor experiments via video and voice links with the Shuttle, send remote commands to their instruments, discuss operations with the crew in space, and coordinate mission activities with their colleagues from other experiment teams. The ESA experiment teams will be backed up by colleagues working at remote sites in Amsterdam, The Netherlands; Brussels, Belgium; Naples, Italy; Toulouse, France; and Cologne, Germany. Additional science teams will be located at the Johnson Space Center and the Kennedy Space Center.

Primary responsibility for operating the experiments in orbit belongs to the Spacelab science crew. Payload Commander Rick Hieb, Mission Specialists Leroy Chiao and Don Thomas, and Payload Specialist Chiaki Mukai will work in two 12-hour shifts. Operating the Spacelab 24 hours a day enables scientists to get the most from valuable time in orbit. The crew will work from a preplanned master timeline, with adjustments made for unexpected opportunities.

After landing, many experiment samples, some of which have limited lifetimes, will be returned to the scientists for evaluation. Later, experiment hardware will be returned to the space agency that developed it. Computer tapes, voice recordings, video tapes and other data will be organized and forwarded to investigators. Analysis of the results will start even before the Shuttle touches down and may continue for several years.

The investigators will be rewarded with new insights into the intrinsic properties of materials, increased knowledge about how gravity affects living systems on Earth, and no doubt new questions to be answered in the unique laboratory of space.

Large Isothermal Furnace

Payload Developer: NASDA

Objective: The Large Isothermal Furnace uniformly heats large materials samples in a vacuum, then cools them rapidly to determine the relationships between the structure, processing and properties of materials. On IML-2, scientists will solidify five samples under various temperature conditions, studying ceramic/metallic composites, semiconductor alloys, and liquid phase sintering. Sintering is a process for combining dissimilar metals, using heat and pressure to join them without reaching the melting point of one or both metals.

Significance: Knowledge gained from post-flight sample analysis will help scientists better understand and improve production techniques on Earth. They also will use the results to assess the feasibility of producing unique materials in space.

Science: In order to create lighter, stronger or more temperature-resistant materials, metallurgists often combine two or more different metals into an alloy which has more desirable qualities than each of its ingredients. Or they may combine dissimilar substances such as metals and ceramics to produce structural materials that are stronger and lighter than conventional metals.

The key to success is the uniform distribution of the various chemical components throughout the finished product. On Earth, gravity causes ingredients with dissimilar densities to settle differently as heavier components are pulled downward. This gravity-induced movement, called sedimentation, causes uneven particle distribution throughout the material. It can diminish the uniformity of its microscopic structure, distort the finished product's shape, and decrease the precision of the casting process.

A microgravity environment greatly reduces buoyancy-driven convection and sedimentation. This may allow the uniform mixture of dissimilar materials in spite of great density differences.

Experiment Hardware and Operations: The facility is a resistance-heated vacuum furnace designed to uniformly heat large samples. It has a maximum operating temperature of about 2,900 degrees Fahrenheit (1,600 °C) and can rapidly cool a sample by admitting helium gas into the heating chamber.

The furnace consists of a sample container and heating element, surrounded by a vacuum chamber. A crew member inserts a sample cartridge through an access port in the front of the facility. A screw-type connector secures the sample in the furnace. Air within the chamber is evacuated through the Spacelab vent system.

The furnace control equipment runs through a pre-programmed heating/cooling cycle to process the sample, and data from temperature sensors are recorded. A gas-driven piston within the sample cartridge can be used to apply pressure to the sample during the experiment.

At the end of the experiment, helium gas is injected into the furnace to allow rapid cooling of the sample. The cartridge is then removed and another can be installed to start a new experiment. Sample cartridges are returned to Earth for analysis.

Background: The Large Isothermal Furnace was developed by the National Space Development Agency of Japan (NASDA). It flew on the Spacelab-J mission in September 1992. Eight samples were processed successfully during that flight and are being analyzed by investigators.

Gravitational Role in Liquid Phase Sintering

Experiment Facility: Large Isothermal Furnace
Principal Investigator:
Dr. Randall M. German
Pennsylvania State University
University Park, Pa.

Objective: This experiment will determine how gravity changes heavy alloys of tungsten, nickel and iron during sintering, a process for combining dissimilar metals. Sintering uses heat and pressure to join powdered forms of different metals without both components.

The material will be heated so the iron and nickel form a liquid, surrounding the uniformly dispersed powdered tungsten. Samples will be analyzed post-flight to investigate both macrostructural changes, such as those in shape and texture, and microstructural changes, including density and high-temperature strength.

Significance: Liquid phase sintering is a process used to produce alloys of novel compositions. For example, due to density differences between the tungsten and the iron-nickel liquid that forms at high temperatures, sintering is the only process by which this alloy can be fabricated. This IML-2 investigation will add to ground-based research, which indicates that gravity plays a role in distorting the microstructure of samples sintered on Earth. Tungsten heavy alloys were chosen for this experiment because of widespread interest in the alloy system, extensive sintering experience on Earth, a large database on properties, and approximately a factor of two density difference between the liquid and solid phases.

Background: Five different compositions of tungsten-nickel alloy were sintered at 2,730 degrees Fahrenheit (1,500 degrees C) in the Large Isothermal Furnace during the Spacelab-J mission. One sample set was sintered for 60 minutes, and another was sintered for 300 minutes. Samples with larger percentages of nickel tended to behave like liquids. Since they were not distorted by gravity as they would have been on Earth, they solidified into spherical shapes. Scientists concluded that the mixture of liquid and small solid particles behaves like liquid in microgravity, regardless of density differences in the materials, when a continuous liquid layer is formed at the surface.

Operations: A crew member will load a sample cartridge containing seven different compositions of tungsten heavy alloy into the Large Isothermal Furnace, then activate a preprogrammed, computer-controlled processing sequence. The cartridge will be rapidly heated to 2,730 degrees Fahrenheit (1,500 degrees C) for a little over an hour, gradually cooled with water for almost another hour, then rapidly cooled by a continuous flow of helium for about 3-1/2 hours more. The astronaut then will remove the cartridge and stow it for return to Earth.

The procedure will be repeated with two more cartridges. Sintering time and sample composition will be varied to identify their effects on final properties of the composites.

The samples, as well as thermal and acceleration data collected during the experiment, will be analyzed post-flight.

Mixing of a Melt of Multicomponent Compound Semiconductor

Experiment Facility: Large Isothermal Furnace
Principal Investigator:

Dr. Akira Hirata
Waseda University
Tokyo, Japan

Objective: This investigation will develop a new method for uniformly mixing melted compound semiconductors. It will test whether the components can be mixed faster and more uniformly using Marangoni convection, that is, fluid flows driven by the concentration differences on the surface of a liquid.

Science: Semiconductors are made of several constituents with different densities. On Earth, gravity separates the components, as heavier materials settle from lighter ones. In space, without any mixing devices, it may be possible to mix these components more uniformly and faster using Marangoni convection, a type of fluid flow driven by differences in surface tension. Although these flows exist on Earth, they are masked by the much stronger forces of sedimentation and buoyancy-driven convection, caused by density differences within the liquid.

Surface tension is the force which causes falling water to form into drops. In space, away from gravity's distortion, it forms an uncontained liquid into a perfect sphere. Previous space experiments have demonstrated that variations in the temperature on the free surface of a fluid create predictable flow patterns within that fluid. Investigators for this experiment will test whether this gentle flow is a useful tool for uniformly mixing semiconductor components.

Significance: Semiconductors are materials whose conductivity is poor at low temperatures, but is improved by application of heat, light or voltage. They are widely used in computers and other electronic devices to transmit electrons in a controlled manner. A better mixture would result in a semiconductor with more uniform content, allowing it to transmit electrons more efficiently.

Operations: Two different compounds of indium-gallium-antimony (InGaSb) will be melted and solidified in the Large Isothermal Furnace to form semiconductors. The experiment cartridge will contain a total of six samples.

Four samples will be processed using Marangoni convection to mix the components. As a material cools and contracts, a void is left in the sample ampoule. Material next to the void forms a free surface which does not touch the sides of the ampoule, allowing Marangoni convection to occur.

Two samples will be processed using only molecular diffusion to mix the components. The void created by cooling and contraction, and the resulting free surface will be eliminated by a gas-driven piston within the cartridge. It will automatically move forward to take up the empty space as the sample material contracts.

The solidified crystals will be compared postflight to determine crystal quality, crystal shape, and size of crystal particulates. Scientists also will compare the effects of the two processing methods on mixing of the melted components and the uniformity of the solidified semiconductor.

Background: Dr. Masami Tatsumi grew an indium-gallium-arsenide crystal in the Spacelab-J Gradient Heating Furnace. A piston was used to prevent Marangoni convection within that experiment. The resulting mixture was more uniform than that of a comparison crystal grown on Earth, but it was not completely homogeneous.

Effect of Weightlessness on Microstructure and Strength of Ordered TiAl Intermetallic Alloys

Experiment Facility: Large Isothermal Furnace
Principal Investigator:
Dr. Masao Takeyama
National Research Institute of Metals
Tokyo, Japan

Objective: This experiment will melt and resolidify a titanium-aluminum alloy to which ceramic particles of titanium diboride have been added. The particles should increase the high-temperature strength of the material, improving the microstructure and thus the mechanical properties of the alloy.

Science: Ceramic particles must be evenly distributed within an alloy to improve grain structure and mechanical properties. On Earth, differences in density between the particles and the alloy prevent uniform distribution, because gravity pulls the heavier particles downward. In microgravity, the uneven distribution caused by density differences should be prevented. Heat convection, which also affects solidification, should be minimal.

Significance: Results should help investigators understand some of the principal influences that occur during this type of material processing. Insights gained about microstructural control could be applied to producing more effective materials on Earth. This technology for controlling alloy microstructure may be applied to improve high-temperature alloys needed for high-tech aircraft and spacecraft.

Operations: A crew member will place a cartridge containing four titanium-aluminum samples, each 18 mm in diameter and 25 mm long, in the Large Isothermal Furnace. Two of the samples will have ceramic particles added; the others will not. They will be heated to approximately 2820 degrees Fahrenheit (1550 degrees C), then solidified in microgravity.

This is planned to be the last sample cartridge processed in the furnace during IML-2, and it will remain in the facility until after landing. Post flight, scientists will study the effect of the resulting microstructure on mechanical properties such as strength. In addition to the two flight samples being compared with one another, they will be compared with those processed on the ground.

Electromagnetic Containerless Processing Facility
Tiegelfreies Elektromagnetisches Prozessieren Unter Schwerelosigkeit (TEMPUS)

Payload Developer: German Space Agency (DARA)

Objective: To study the solidification of materials from the liquid state, a subject of immense scientific and practical interest. Not only are solidification phenomena important to science, but many industrial processes involve solidification.

On Earth, liquids generally must be held in containers, which can affect the liquid's properties. For example, a container determines a liquid's shape, and contact with the container walls can diminish the purity of the metal sample.

In microgravity, samples can be processed in a containerless facility, which avoids contact with any surface. The Electromagnetic Containerless Processing Facility, known as TEMPUS, is a levitation melting facility for containerless processing of metallic samples in an ultraclean microgravity environment. It was developed by the German Space Agency.

Science: In the absence of a container, most pure molten metals can be cooled to below their solidification point and still remain fluid. Crystalline solidification begins when small, isolated clusters of atoms arrange in a regular, repeating form. This process is known as nucleation, and the clusters are called nuclei. Atoms fall into place on these clusters causing the sites to grow until the entire mass becomes solid.

Nucleation occurs at solid to liquid boundaries, such as the boundary between solid container walls and the liquid sample it holds. The container walls, consisting of arranged atoms, act as the nuclei site. The resulting solid will appear as a patchwork of many small crystals as opposed to fewer, larger crystals produced by fewer nucleation sites in microgravity. It is this undercooling phenomenon that scientists are interested in studying.

Background: This is the maiden flight for the TEMPUS facility. The 22 samples accommodated by the facility are being shared by many of the principal investigators so as to gather the maximum scientific data from the limited number of alloy samples available. Therefore, as a general rule, each sample is of interest to more than one principal investigator.

Hardware: The TEMPUS system uses an electric current flowing through coils of copper tubes to produce magnetic fields. By carefully forming the coils, it is possible to create an area of minimum field strength in which the sample will levitate or float.

On Earth, lifting a sample in apparent defiance of gravity requires a very powerful electromagnetic force. Not only does this deform the sample and agitate the melted alloy, but independent temperature control is impossible. In microgravity, positioning of the sample and temperature control can be accomplished accurately and precisely because the power necessary for positioning the sample is greatly reduced. The reduced amount of current results in diminished fluid motion which is less intrusive on the phenomena being examined.

The 22 spherical specimens, each up to 0.4 inch (10 millimeters) in diameter, can be accommodated on a storage disk within the TEMPUS unit. The disk rotates until the desired specimen is positioned over a transfer mechanism. The mechanism unlocks the sample holder and transfers the sample to the processing area within the levitation coils. Processing can occur in a vacuum, or in an ultra-pure helium/argon atmosphere. As the sample cools, experimental data are recorded. Different views of the process are recorded by video cameras.

The TEMPUS system provides the means for physically manipulating the sample during processing. Rotations and oscillations can be controlled through the application of a direct current magnetic field. Nucleation can be initiated at any desired undercooled temperature by touching the sample with a needle driven by the transfer mechanism, causing the entire sample to rapidly solidify. Also, the sample can be vibrated by applying short power pulses to the heating or levitation coils. By observing how the sample reacts to vibration, properties such as surface tension and viscosity can be inferred.

Operations: Experiment procedures are almost completely microprocessor-controlled and require very little crew interaction other than start up and shut down. The TEMPUS unit is reprogrammed between each experiment from the ground. The crew on board, or ground controllers, can modify any experiment parameters during sample processing.

The team of investigators will study various thermodynamic and kinetic properties of 22 samples. The metallic samples have melting points between 1634 and 3362 degrees Fahrenheit (890 and 1850 degrees C) when heated in the TEMPUS unit.

Effects of Nucleation by Containerless Processing in Low Gravity

Experiment Facility: TEMPUS

Principal Investigator:

Robert J. Bayuzick
Vanderbilt University
Nashville, Tenn.

Objective: This experiment has a two-fold purpose:
- to better understand specific details of how metals solidify, and
- to investigate ways in which the solidification process can be controlled.

An extensive series of experiment runs will be conducted to provide comparative data for determining the time and temperature at which a metal begins to turn into a solid. Scientists hope to pinpoint what phenomenon "kicks-off" the solidification process. The series will be conducted in the Electromagnetic Containerless Processing Facility or TEMPUS.

On Earth, the electromagnetic force necessary to levitate the sample so that it floats in apparent defiance of gravity, is so powerful that it deforms and agitates the molten metal sample. Also, levitation techniques in a 1-g environment result in large liquid flows, or convection currents, within the sample. In microgravity, the amount of electromagnetic forces required is reduced, thus causing less disturbance and stress to the free-floating, spherical sample. This containerless environment will allow the molten metal to nucleate and grow a crystal without being influenced by a container's molecular structure.

Science: Pure liquid metals can remain in a liquid state below the point at which they should solidify. This process is called undercooling. In this experiment, scientists will try to keep the metal in a molten state for as long as possible, at the lowest possible temperature.

The condition when an undercooled liquid first begins to solidify is called nucleation. A cluster of atoms acts as a nucleation site, or foundation, for the crystal to build upon. Free-moving atoms attach themselves to this site, growing into a solid crystal structure. Scientists hope to determine the nucleation properties for the element zirconium, a strong, ductile metallic element used chiefly in ceramic and refractory compounds as an alloying agent. The nucleation properties are what characterize the molten liquid's random movement of atoms into an ordered pattern as a solid metal. Scientists want to study this process under the condition of a high degree of undercooling.

Significance: Solidifying metals is one of the most important processes in industry. Learning more about the basic nucleation phenomena may provide clues for making different materials. The nucleation phenomenon is the most basic process governing the solidification of metals.

Background: This experiment has been performed on Earth using drop tubes that simulate low gravity for a few seconds. However, the precise measurement of temperature is difficult because during freefall the specimen is moving with respect to the detectors.

Operations: A spherical sample of zirconium about three-eighths of an inch (8 to 10 mm) in diameter will be levitated, heated to 3542 degrees Fahrenheit (1950 degrees Celsius), melted and then cooled about 300 degrees below the normal solidification point when nucleation is expected to take place. The experiment will consist of approximately 100 melting, cooling, nucleation and solidification cycles. The series will take place over four hours. Each time the sample is melted and resolidified, the nucleation temperature and rate of crystal growth will be recorded for comparison with Earth-based results to further the understanding of nucleation phenomena.

Non-Equilibrium Solidification of Largely Undercooled Melts

Experiment Facility: TEMPUS

Principal Investigator:
Dr. Dieter M. Herlach
DLR Institute for Space Simulation
Cologne, Germany

Objective: This experiment has a two-fold objective. First, it will investigate dendritic and eutectic solidification velocity resulting from undercooling. These measurements can be used to test and refine dendritic and eutectic solidification theories. Second, this investigation will study the nucleation of metastable phases below an alloy's normal solidification temperature.

Science: Dendrites -- from the Greek word for "tree" -- are tiny branching structures that form inside molten metal alloys when they solidify during manufacturing. The size, shape and structure of the dendrites have a major effect on the strength, ductility and usefulness of an alloy.

A eutectic substance -- also from a Greek word ("well-melting") -- is a material that has a melting point lower than that of any of its components. This property makes it an important material, one whose microstructure has a strong impact on mechanical, electrical and magnetic properties. An example of the eutectic phenomenon is putting salt onto ice. The salt-water mixture lowers the melting point, causing the ice to melt.

Nucleation is the starting point for solidification. The tiniest possible crystal, which scientists call an embryo, sets the solidification process into motion. If the atomic arrangement within the embryo differs from that in the usual stable solid, a metastable crystalline phase forms.

The atoms of these metastable crystals have different structural arrangements that change the alloy's properties, such as improving mechanical elasticity and strength. Coal is an example of a material produced at the normal solidification temperature. It is the stable, solid form of carbon. When the atomic structure solidifies at specific conditions, a diamond is created. Diamond is the metastable solid form of carbon. This means that in thousands of years a diamond will eventually turn into a piece of coal, the material's more stable form. When nucleation occurs at other temperatures below the normal solidification point, other materials can be created. Coal and diamond are just two of many possibilities, all dependent on the conditions at which nucleation occurs.

Significance: There are two reasons why these experiments are performed in microgravity. First, crystal growth can be strongly affected by convective fluid flow in the molten metal. The low acceleration environment in space effectively eliminates convection. Comparing space experiment data with Earth experiment data is the only practical way to separate the effects of convection from the underlying mechanism of crystal growth. On the other hand, the experiment conditions such as containerless processing of melts in an ultraclean environment promise a substantial extension of the degree of undercooling that can be achieved. It is at these very low undercooling temperatures that scientists hope to observe the nucleation of various metastable phases.

Operations: Two methods will be used to study these phenomena in the containerless environment provided within the TEMPUS facility. First, iron-nickel, nickel-carbon and nickel-silicon will be heated to 100 degrees above their melting point. Then they will be allowed to cool as far into the undercooling range as possible, until nucleation spontaneously occurs, and many independent, separate dendrites grow. The solidification velocity will be measured once nucleation occurs.

The second method will use a needle to terminate the undercooling phase. The needle will provide a nucleation site, inducing solidification at a specific temperature below the normal solidification point. Investigators will carefully control where and when dendrites begin to grow inside the experiment sample.

Several different time profiles at various temperatures will be obtained for each sample. The microstructure of the materials will be analyzed post flight, along with temperature, pressure and acceleration data.

Alloy Undercooling Experiments

Experiment Facility: TEMPUS

Principal Investigator:

Dr. Merton C. Flemings
Massachusetts Institute of Technology
Cambridge, Mass.

Objective: Atoms in a molten liquid alloy line up in a specified order as the alloy cools and becomes a solid crystal. Scientists hope to learn more about the order in which atoms attach to each other as they grow into a crystal structure. They also want to study the speed at which the crystallization process occurs.

Science: Liquid alloys allowed to solidify slowly at their natural freezing point repeatedly form what is called an equilibrium atomic structure. Atoms are consistently ordered in an identical pattern. When the solidification process is changed, the atomic structure is affected. Molten liquids that are undercooled below the point where they usually become a solid crystallize faster than when they solidify at their normal freezing point. The particles are frozen rapidly right where they are, in a matter of milliseconds. This quick cooling creates metastable solid phases that are not considered "normal" or stable. Scientists hope their results reveal how the fast-frozen solids are different and if the metal alloy's characteristics are improved. It is possible the alloy will be stronger.

The metal's properties are expected to change because undercooling allows the scientist to "supersaturate" the nickel-tin alloy. Tin makes up a small percentage of the initial alloy sample. However, when the alloy is supersaturated, a higher concentration of the sample is comprised of tin. This should alter the metal's properties.

Significance: Scientists and engineers will study the experiment results to determine how the properties of metals change in an unstable fast-frozen, supersaturated state. This may help industry make better metals. For example, in the casting of high-performance metal components like jet engine turbine blades, each blade is the result of a crystal grown from a single nucleation site. Improving this process may make possible turbine blades that would have greater operating efficiency if the blades can be constructed of a metal capable of withstanding higher temperatures.

Operations: Three alloy samples will be levitated, melted and solidified in the Electromagnetic Containerless Processing Facility, nicknamed TEMPUS. Two nickel-tin spheres, one containing 25 percent tin and one almost one-third tin, will be tested and a third sample, of pure nickel, will be processed for a control experiment.

Structure and Solidification of Largely Undercooled Melts of Quasicrystal-Forming Alloys

Experiment Facility: TEMPUS

Principal Investigator:

Dr. Knut Urban
Institute for Solid State Physics Research Center Julich
Julich, Germany

Objective: This experiment studies a unique feature of some metallic alloys - the presence of structural elements based on atom arrangements with 20 triangular sides, a shape called icosahedral. These multi-sided structures are a fairly recent discovery known as quasicrystals.

Science: Quasicrystals are so small they are called nano-crystals. Scientists are not even sure they can be considered true crystals. Because they are multi-sided -- having the icosahedral shape -- they are unstable building blocks. Therefore, they are distributed in small pockets throughout some metal alloys. As an analogy, children's building blocks -- squares, triangles and rectangles -- fit together in repetitive patterns forming a sturdy, solid structure. However, icosahedral shapes cannot tightly fit together, leaving empty spaces that weaken a building arrangement such as a crystal structure.

This investigation also is interested in the undercooling phenomena of these quasicrystals. Using the TEMPUS facility, metallic alloys can be cooled well below their melting temperature without solidification.

The quasicrystalline state in metallic alloys was discovered in 1984 as the third state of solid matter. The other two are normal crystalline and glassy states. Quasicrystals exhibit excellent structural order based on atom arrangements that do not permit long-range periodicity. This feature provides quasicrystalline materials with a high degree of hardness and novel electrical and physical properties. Small pockets of quasicrystals are located throughout the alloy.

Significance: This experiment contributes not only to the understanding of why and how these new quasicrystals form, but also to our knowledge about the structure of molten alloys. Scientists hope to gain insight into how atoms cluster together and eventually grow into a crystal, a process called nucleation.

Operations: Spherical samples of aluminum-copper-cobalt and aluminum-copper-iron about three-eighths of an inch in diameter (8 to 10 mm) will be levitated, melted and solidified at different temperatures using the TEMPUS. The samples will be analyzed post flight and the temperature, pressure and acceleration data recorded during the STS-65 flight, will be studied.

Thermodynamics and Glass Formation in Undercooled Liquid Alloys

Experiment Facility: TEMPUS

Principal Investigator:
Dr. Hans J. Fecht
Technical University-Berlin
Berlin, Germany

Metallic Glass Research in Space: Thermophysical Properties of Metallic Glasses and Undercooled Alloys

Experiment Facility: TEMPUS

Principal Investigator:
Dr. William L. Johnson
California Institute of Technology
Pasadena, Calif.

The objective and significance of Dr. Johnson's, as well as Dr. Fecht's investigations, are quite similar. The experimenters share their data and results, which is why they also can be described together. Dr. Fecht's experiment uses three alloys: zirconium-iron, zirconium-cobalt and zirconium-nickel. Dr. Johnson's alloys are zirconium-nickel and niobium-nickel.

Objective: This experiment uses a new mathematical method, termed the AC method, to calculate heat capacity, an important physical characteristic of metallic alloys cooled to temperatures below the point when they would normally solidify. While the formula has been evolving over several years, this will be the first time it has been used to determine heat capacity. This is possible because pure molten alloys can remain liquid at cooler-than-normal temperatures when they are suspended in a containerless processing environment such as that provided by the TEMPUS facility.

Science: A key point in understanding the physics of this experiment is that undercooled metals can remain molten many degrees below the temperature at which they normally start to form a solid crystal. At these reduced temperatures, areas with a glass-like quality can form in zirconium-based alloys. While these are not transparent, they are referred to as glass because the atoms are arranged in a similar pattern as glass used for windowpanes. The angles at which atoms are joined is not regular; in fact, the atomic structure has no long-range order at all.

As short, repetitive bursts of heat are rapidly applied to the alloy sample, its temperature will correspondingly rise and fall. This temperature increase or decrease lags slightly behind the influx of heat, which is modulated through the metal in a wavelike fashion. The time difference between the addition or subtraction of heat and the resulting temperature fluctuations is directly related to the alloy's heat capacity, defined as the amount of heat required to increase the temperature of 1 gram of material by 1 degree Celsius. Scientists will use specially designed computer software to determine the heat capacity from this temperature lag.

Significance: Understanding the fundamentals of undercooling and formation of metallic glasses is vital for designing such materials. They may find applications in many technological areas because of their unique mechanical and physical properties. Some present areas of application include high-powered laser choke switches, transformer cores, brazing alloys, wear-resistant coatings, and reinforcing fibers in metal matrices. In the future, these injection-molded, bulk metallic glasses could influence the state of materials science and engineering.

Operations: The pure metal samples and the alloys will be levitated and heated above their melting point and then allowed to cool until they solidify. These experiments involve a series of melting-solidification.

Viscosity and Surface Tension of Undercooled Melts

Experiment Facility: TEMPUS
Principal Investigator:
Dr. Ivan Egry
DLR Institute for Space Simulation
Cologne, Germany

Measurement of the Viscosity and Surface Tension of Undercooled Melts under Microgravity Conditions and Supporting Magnetohydrodynamic Calculations

Experiment Facility: TEMPUS
Principal Investigator:
Dr. Julian Szekely
Massachusetts Institute of Technology
Cambridge, Mass.

The experiments of Drs. Egry and Szekely show the same area of specialization and follow identical procedures. Therefore only one description is necessary to explain the background and the goal of these experiments. Dr. Egry uses samples of the system gold-nickel; Dr. Szekely uses gold-copper samples.

Objective: The aim is to gain a better understanding of microscopic interactions within molten metals, such as gold, in the unusual condition of undercooling. This experiment specifically focuses on studying viscosity and surface tension characteristics. Such measurements on undercooled metals have never before been possible. On the ground, gravity distorts the molten sample, making it difficult to determine what is taking place at the atomic level.

Science: The study of viscosity and the measurement of surface tension have to do with microscopic interactions within molten metals. Materials that have high viscosity are thick and flow slowly, such as molasses and 50-weight oil as compared to 10-weight oil. Materials with low viscosity are thin and flow readily, such as water. A droplet made up of gold atoms has an even lower viscosity and therefore is expected to take a long time returning to a stable, non-oscillating sphere.

Surface tension is the force acting in the surface of a liquid -- similar to a membrane -- that causes a quantity of liquid to try to minimize its total surface area. For example, it causes a drop to be spherical, in the absence of gravity.

When a liquid drop is levitated and its normally spherical shape is disturbed, it will return to a sphere through a series of oscillations. The surface tension may be deduced from the frequency of the oscillations. Viscosity can be determined from the rate at which these oscillations slow down to a stable spherical shape.

Significance: Understanding the underlying principles governing thermophysical properties of liquid metals, in particular, viscosity and surface tension, is a matter of high scientific interest and of benefit to industries, such as electronics and manufacturing.

Knowledge of the viscosity of melts below the temperature at which they solidify will make an important contribution to the study of fluid dynamics of undercooled liquid metals. The growing field of electromagnetic processing of materials, especially the area of electromagnetic shaping of electrically conducting fluids, will benefit from this research.

Operations: This experiment will levitate and heat a gold-copper alloy sample and a pure copper sample. Then the heating unit will be switched off, and the liquid metal will be cooled below its melting point. At predetermined temperatures, the sample will be squeezed by pulsing the heating coils, thus producing oscillations in the sample. When the squeezing force is switched off, scientists on the ground will monitor the frequency and rate of decay of the oscillations until the metal sample becomes stable and stops oscillating.

Free Flow Electrophoresis Unit (FFEU)

Payload Developer: NASDA

Objective: The Free-Flow Electrophoresis Unit is being used to study whether space-based electrophoresis will improve the purity of certain biological materials which are normally difficult to separate on Earth. Electrophoresis is a process that separates biological materials into individual components using electric fields. The method is widely used with gel matrix in the DNA sequence analysis and clinical diagnosis.

Significance: Widely used Earth-based electrophoresis is run in a gel matrix providing better separation, but limited for only small molecules. Matrix free free-flow electrophoresis, however, tends to remix the components during separation. Gravity-induced fluid movements such as convection (fluid flows caused by density differences) and sedimentation (settling of heavier components) tend to remix the components during separation. This prevents the production of suitable quantities of very pure substances. In space, however, with gravity no longer a dominant factor, these effects are minimal.

In space, other physical processes affecting the separation of molecules, which are masked by gravity on Earth, become more apparent. Scientists are interested in how these effects might influence future space-based electrophoresis. They also can use what they learn to better understand electrophoresis processes on Earth.

Science: Particles of any element or compound have an electrical charge. When exposed to an electric field, a charged molecule of an element will move toward the side of the field with the opposite charge. Eventually, all the molecules within a fluid will segregate according to their charge.

Molecules separate not only according to whether they are positively or negatively charged, but also according to the strength of the charge and the size of the molecule. Molecules with greater positive or negative charges move more quickly than those with less charge. Movement of larger molecules is slowed by increased resistance from the solution in which they are suspended.

During electrophoresis separation on Earth, gravity introduces flows which mix and disperse components of a solution. For molecules with nearly the same charge, the fluid movement is a more powerful influence than the tug of the electric field. Microgravity virtually eliminates these flows, making possible more thorough separation and thus more pure materials.

Background: This facility is furnished by the National Space Development Agency of Japan. Along with the Thermoelectric Incubator, Cell Culture Kits and the Aquatic Animal Experiment Unit, it was part of the First Material Processing Test - Life Sciences which flew aboard Spacelab-J in 1992. IML-2 experiments will add to experience gained during the earlier mission to evaluate how much microgravity increases the effectiveness of electrophoretic separation.

McDonnell Douglas Corp. flew a Continuous Flow Electrophoresis Experiment on several Space Shuttle flights in the early 1980s.

Operations: The Free Flow Electrophoresis Unit separates and analyzes the distribution of materials in a solution, using a method called continuous-flow electrophoresis. In this method, material to be separated is placed into a moving stream of buffer solution. As the material passes through an electric field, the components separate into individual streams within the solution. The constant flow of material allows processing of large quantities of product.

Three types of buffer solutions are contained in separate tanks. A crew member will inject the biological sample into the main electrophoresis unit, along with the selected buffer solution. The astronaut then will apply an electric field across the flowing solution stream to charge the particles suspended in it. Individual components within the mixture will separate into sub-streams, based on their relative charge and size, then flow into up to 60 separation collection tubes which can be stowed for post-flight analysis.

The crew in space and scientists on the ground monitor progress of the experiment through a display window at the top of the facility. Depending on the samples being studied, they can determine concentrations of the various separation products by how they scatter light or by how much ultraviolet light the products absorb.

Gravitational Role in Electrophoretic Separations of Pituitary Cells and Granules

Experiment Facility: FFEU
Principal Investigator:
Dr. Wes Hymer
Pennsylvania State University
University Park, Pa.

Objective: This experiment will use electrophoresis to separate pituitary cells which produce different hormones into single hormone producing components. The results will evaluate whether separation in microgravity is superior to separation on Earth. In addition, the experiment will help determine how pituitary growth hormone and prolactin, an immune-system controller, are affected by spaceflight.

Science: The pituitary system produces many hormones which regulate how the body functions. Two of the hormones which are produced throughout life are growth hormone and prolactin. Growth hormone not only promotes development of long bones during adolescence; it also increases muscle mass and promotes the breakdown of fat in adults. Prolactin plays a part in controlling the immune system and stimulating milk production in women after birth. Growth hormone and prolactin come from types of specialized pituitary cells which manufacture the hormones and store them in secretory granules inside the cells before release into the bloodstream.

Microgravity has been shown to negatively influence parts of this system in humans and animals. This experiment will attempt to determine whether the changes observed in pituitary cells after spaceflight are caused by an alteration to the surface of the cell, or by changes within the internal cell structure.

Significance: In addition to furthering scientific knowledge of electrophoresis techniques, this experiment will shed light on how spaceflight affects growth hormone and prolactin-containing cells and granules, information important to the long-term health of space travelers.

Background: Dr. Hymer studied rats from two Russian Biocosmos missions and from the 1985 Spacelab 3 mission. Post flight studies in each instance showed the rats' pituitary cells were less active after exposure to microgravity. Hymer's Shuttle middeck experiment aboard STS-46 in 1992 flew rat pituitary cells only, but the same changes occurred. This experiment takes his research to the next step, to help determine the reason for the changes.

Operations: Rat pituitary cells loaded in three cell culture chambers are the samples for this experiment.

Products of cells from one chamber will be stored in the Thermoelectric Incubator at 98.6 degrees Fahrenheit (37 °C) for most of the mission. Astronauts will periodically extract samples of the cell products with a syringe and refrigerate them for post flight analysis. Scientists will use these samples to determine structural and functional changes induced by various durations of exposure to microgravity.

A crew member will separate cells carried in the second chamber into 30 Free Flow Electrophoresis Unit tubes. These 30 samples will be cultured in space to determine how the cells function after separation.

On Flight Day 5, pituitary cells from the third chamber will be broken apart into sub-cellular particles. Electrophoresis will be used to separate prolactin and growth hormone granules. The granules will be frozen for post flight analysis to determine if internal changes occurred during the first five days of flight.

Separation of Chromosome DNA of a Nematode, *C. elegans*, by Electrophoresis

Experiment Facility: FFEU
Principal Investigator:

Dr. Hidesaburo Kobayashi
Josai University
Saitama, Japan

Objective: This experiment will employ a sensitive method for electrophoresis called isoelectric focusing to separate chromosome DNA from a nematode worm.

Electrophoresis is a process for separating biological materials into individual components using electric fields. This experiment uses isoelectric focusing, one of several methods for performing continuous flow electrophoresis. Isoelectric focusing is an advanced electrophoresis technique for producing very pure separations of proteins, viruses, cells and other biological materials on a small scale.

Science: Chromosome DNA, or deoxyribonucleic acid, is the element of a cell nucleus which is the molecular basis for heredity in many organisms. The small nematode is an excellent animal for studying the genetic basis for animal development. It is transparent, and its cellular structure is simple, with just six chromosomes.

Because chromosome DNA has nearly constant electric charge density, it cannot be separated from tiny organisms like the nematode worm using standard electrophoresis techniques. Therefore, this experiment will separate the nematode chromosomes based upon their molecular sizes and minimal charge differences. Since there is no gravity-induced convection or mixing in space, the electric charge should be dominant, resulting in a successful separation.

Normally, the solution in which samples are suspended for electrophoresis has a uniformly neutral pH (acid/alkaline) level. In isoloelectric focusing, the pH is graduated from more alkaline to more acidic levels across the buffer solution. The speed with which various molecules move during separation varies according to buffer solution pH levels. Different molecules stop moving, or reach their "isoelectric point," at known pH levels. Therefore, scientists design isolectric focusing experiments so motion of the material they want to collect halts at a given pH level, and unwanted materials pass on to different parts of the buffer solution.

Significance: The ability to separate chromosomes and test the method in space may help solve problems in genetic mapping and molecular biology.

Operations: An astronaut will inject concentrated suspensions of chromosome DNA into the Free Flow Electrophoresis Unit, along with a special buffer solution designed to test isoelectric focusing.

The solution will create a pH (acid/alkaline) gradient in the flow to allow separation of materials with small charge differences. After the suspensions are separated, the astronaut will stow the products in separation tubes for post flight analysis. Investigators on the ground will subject the chromosomes to standard genetic and biochemical tests.

Experiments Separating the Culture Solution of Animal Cells in High Concentration under Microgravity

Experiment Facility: FFEU

Principal Investigator:

Mr. Tsutomu Okusawa
Hitachi, Ltd.
Ibaraki, Japan

Objective: This experiment grows animal cells in cultures, then separates their cellular secretions in the Free Flow Electrophoresis Unit. Animal cells synthesize substances which can be valuable medical drugs. Investigators believe that two fundamental aspects of pharmaceutical production, the rate of separation and the amount of separated product, may be improved by space processing.

Electrophoresis is a process for separating biological materials into individual components using electric fields. It is expected that the method is useful in the production and purification of drugs and medicines on Earth.

Science: Drugs expected to work for cancer diagnosis and treatment include monoclonal antibodies, which are effective for both treatment and prevention because they provide a disease immunity. These antibodies are obtained from cultured animal cells on Earth. In the present commercial production method, animal cells are multiplied to the highest concentration possible in cell cultures. A recent method for culturing animal cells on the ground is being used to grow cells at ten times the previous rate. Then, the useful substance is separated from the culture medium through a refining process. After the medium is passed through a series of filters, final removal of unnecessary substances is accomplished by a process called liquid chromatography. However, the method is complicated and inefficient. The substances must be refined further to obtain a pure pharmaceutical product in larger quantities.

Ground-based electrophoresis has been used to analyze the separation process. It has not been practical for commercial processing, though, because convective flows within the separation fluid caused by gravity reduce its effectiveness.

Separation by electrophoresis in space shows promise for yielding larger amounts of a purer product. In addition, previous experiments indicate that the cells may produce antibodies at much faster rates in microgravity.

Significance: Results from experiments such as this should verify the validity of the electrophoresis method in space and provide useful knowledge for establishing space-based biotechnology production in the future.

Operations: A crew member will place one type of hybrid animal cell from the Cell Culture Kits into the Thermoelectric Incubator, both IML-2 life-science equipment furnished by the Japanese Space Agency. The culture will incubate and grow for five days. Then, the highly concentrated cell solution will be injected into the Free Flow Electrophoresis Unit, where the cellular secretions will be separated from the solution.

The sample will be separated under three different conditions, varying flow rates and the timing and intensity of electrical charges. The crew member operating the experiment and ground controllers will determine which conditions proved the most effective. The fractions of the sample separated under those conditions will be collected and frozen for post-flight analysis.

Aquatic Animal Experiment Unit (AAEU)

Payload Developer: NASDA

Objective: The facility provides an environment supporting studies of live fish and small amphibians under microgravity conditions. It permits observations of spawning, fertilization, embryonic stages, vestibular functioning and behavior in microgravity.

Hardware: This aquarium consists of two independent life-support systems, called fish and aquarium packages.

Small fish and amphibians, such as newts, live in four cassette-type aquariums, and there is a larger tank designed for fish. A special life-support system supplies oxygen, removes carbon dioxide and waste (such as ammonia and organic substances), and regulates the temperature as desired, between 59 and 77 degrees Fahrenheit (15 to 25 degrees C). The crew can view the animals through a window and access them by means of a port in each enclosure.

A video system can be attached to the viewing port for recording observations of behavior, such as swimming patterns. Closeup observations can be made of fertilization and embryonic development. These images, along with housekeeping data on water temperature and pressure and other parameters, are downlinked to scientists supporting the mission on the ground.

Background: The AAEU was flown successfully on the Spacelab-J mission (STS-47), in a slightly different configuration. It was referred to as the vestibular function unit, and supported studies with carp.

Mechanism of Vestibular Adaptation of Fish under Microgravity

Experiment Facility: AAEU
Principal Investigator:

Dr. Akira Takabayashi
Fujita-Gakuen Health University
Toyoake, Japan

Objective: This experiment further explores the hypothesis that space motion sickness is caused by conflicting messages sent from the eyes and the otoliths. Investigators expect to clarify the interaction between otolith organs located in the inner-ear and other gravity-sensing organs. Six goldfish will be used to study how their vestibular systems adapt to microgravity and readapt to Earth's gravity after landing.

Significance: Space motion sickness usually is experienced by roughly half of all human space travelers, and may occur in other species. The investigator's team wants to evaluate mechanisms which may cause space motion sickness. This will help the effort to develop preventive measures.

Science: On the ground, animals control their posture and motion by sensing gravity by means of their vestibular and eye system. Posture control is achieved by integrating information in the brain received from both the eyes and vestibular system. When animals are placed in microgravity, they tend to lose their balance, then gradually adapt with time.

The most important gravity-sensing mechanism is the vestibular-otolith system in the inner ear on both sides of the goldfish. However, in microgravity, goldfish might maintain their balance only by visual input.

Background: This experiment is an extension of an experiment flown as part of Spacelab-J (STS-47).

Operations: In goldfish, the vestibular apparatus contains two otolith organs. Before launch one or both otoliths will be removed by surgery from five goldfish; a sixth goldfish will have both otoliths intact. All six goldfish will be flown in the Aquatic Animal Experiment Unit.

The fish behavior will be videotaped once a day and analyzed after the mission. One aspect of behavior to be observed is how the fish react to light stimulation from a direction perpendicular to the aquarium (dorsal light response). Swimming patterns, including measurements of the tilting angle, velocity, and how these characteristics change over time, will be studied to learn how the fish adapt in microgravity.

After Columbia lands, the readaptation process to Earth's gravity will be observed for 10 days.

Otoconia: Early Development of A Gravity-Receptor Organ in Microgravity

Experiment Facility: AAEU
Principal Investigator:
Dr. Michael L. Wiederhold
University of Texas Health Science Center
San Antonio, Texas

Objective: The purpose is to study how the gravity-sensing organs located in the middle ear develop in microgravity using embryos of the Japanese red-bellied newt. Scientists will study the development of both the gravity-sensing otolith organs and angular-acceleration sensors, the semicircular canals.

Science: All vertebrates (creatures with a spinal column) and most invertebrates have specialized receptors in their inner ears to sense gravity. In many organisms, including humans, this gravity perception occurs in organs known as otoliths. The organ contains mineral crystals called otoconia. The organ detects gravity by an interaction of the otoconia and tiny hairs (cilia) inside the inner ear. The crystals have greater density than the fluid surrounding them, so gravity pulls them down. The fall of the crystals (stones) on the hairs deflects hair bundles on top of the hair cells, causes excitation of vestibular-nerve fibers to the brain indicating body position.

There is uncertainty about how the crystals, their associated receptor cells and the connections of the nerve fibers within the brain develop in space without gravity.

The investigator's team wants to clarify this reflex process and also study growth development in the absence of gravity.

Significance: Observations should clarify gravity-dependent vestibular information processing. These findings will help explain the fundamental role of gravity on the otoliths and how it affects development of balance control.

Operations: The development process of the vestibular system including rotational acceleration sensors or semicircular canals will be investigated using Japanese red-bellied newts. Newts are very suitable for this experiment because these animals' vestibular system can develop within the planned IML-2 mission duration of 14 days.

Female newts will be used, since they store the fertilized eggs in their bodies. The crew injects some of the newts with a hormone during the spaceflight to observe the early development of the gravity sensor in an embryo grown in a microgravity environment. The size of the otoliths and associated sensory structures will be determined by three-dimensional reconstruction of sections of the inner ear.

The rate of calcification will be determined by labeling new calcium deposits with two different fluorescent calcium-binding dyes applied four days apart. Otolith function will be assessed by examining the newts' larvae vestibular-ocular reflex.

Data from the newts flown in microgravity will be compared to controls on the ground, to embryos whose growth began three to five days before launch, and to newt embryos whose growth began on orbit. By comparing these groups, the investigators can determine if otoconial formation proceeds normally in microgravity.

Fertilization and Embryonic Development of Japanese Newts in Space

Experiment Facility: AAEU
Principal Investigator:
Dr. Masamichi Yamashita
Institute for Space and Astronautical Science
Kanagawa, Japan

Objective: Unique aquatic animals will be used to investigate the effects of gravity on cells during early developmental stages.

Science: Previous experiments have indicated that gravity affects amphibian eggs before their first cleavage. A single egg divides into many cells, and those cells mature or differentiate to form all the organs whose function makes up the living organism. Gravity is one factor that regulates this process. By studying cell differentiation in microgravity, scientists may be able to determine the effects of gravity on cells at early developmental stages.

The Japanese newt starts its life from a large, single-cell egg. Gravity plays a role in the egg's development by orienting the heavy vegetal hemisphere of the egg downward. Early stages of development may be very sensitive to gravity. This may occur even before the single cell divides into two cells. To investigate this effect, scientists will study newt eggs exposed to microgravity.

Significance: Fertilized newt eggs will be observed during the most dynamic stage of their life. Findings on the effects of the absence of gravity on their early development could help scientists acquire knowledge about the benefits of Earth's gravity for a biological system in early developmental stages and the mechanisms involved.

Background: The experiment on IML-2 may enrich scientific results and provide a larger number of specimens to establish a good statistical base. It also provides an opportunity to compare data from independent experiments. This "AstroNewt" experiment also is scheduled to fly on the first mission of the Space Flyer Unit. This Japanese space platform will be launched by an H-II rocket.

Operations: Japanese red-bellied newts mate in the autumn. The female newts go into hibernation, storing sperm in their bodies for fertilizing their eggs in the springtime. The hibernating newts will be collected and stored under controlled conditions until just before the STS-65 launch. Hibernation can be successfully terminated at any time by warming the creatures to 59 degrees Fahrenheit (15 degrees Celsius).

During the IML-2 mission, four newts will be kept in three water tanks in the Aquatic Animal Experiment Unit onboard Columbia. The female newts will be induced by a hormonal treatment to lay eggs in the water tanks. Two newts will receive a hormone injection on the ground prior to launch. This should result in their laying eggs three to four days later. Crew members will inject the other two newts in space.

When space-borne eggs are obtained, those eggs are isolated from the mothers by a partition. Close-up video images of the eggs and embryos will be recorded to trace their time course of development.

Some embryos will be preserved at specific development stages, while some will continue further development after Columbia lands. They will be kept until they hatch on Earth for the morphological and behavior studies.

A simultaneous control experiment will be conducted on the ground.

The adult newts and eggs will be shared with Dr. Wiederhold's "Otoconia" experiment.

Mating Behavior of the Fish (Medaka) and Development of Their Eggs in Space

Experiment Facility: AAEU
Principal Investigator:
Dr. Ken-ichi Ijiri
University of Tokyo
Tokyo, Japan

Objective: To study whether the freshwater fish, Medaka, can mate and lay eggs under the weightlessness conditions of spaceflight. If eggs are laid, scientists will study their development. The swimming behavior of this special strain of Medaka also will be observed during and after the flight.

Significance: Aquaculture in space could become an important nutritional theme in the future. Fish may be included in a controlled ecological life-support system being developed for long-term human stays in space.

In a practical system, fish would mate and spawn eggs, thus increasing their numbers. This experiment tests the feasibility of such an aquaculture design in microgravity, checking the mating behavior and embryonic development of a small fish. Results may help scientists plan other experiments for breeding fish in space.

Science: Medaka is a small freshwater fish commonly found in ponds and rivers all over Japan's countryside. It is an excellent experimental species because it has a relatively short life cycle of three months from one generation to the next. Also, the transparent body provides for easy observation and identification of its organs during embryonic development. Therefore, scientists can determine whether microgravity impacts normal development processes.

Fish usually swim in loop patterns when they are exposed to microgravity. However, a special breed of the Medaka species has not exhibited this behavior when exposed to microgravity for short periods of time on parabolic flights aboard aircraft. This tolerance to microgravity should be inherited by future generations of this breed. This experiment will examine whether this strain continues to swim normally during a longer stay in space.

Operations: Two pairs of male and female Medaka will be transferred to a small cassette-type aquarium about two days prior to launch. The life support for the Medaka is continuously provided by the Aquatic Animal Experiment Unit for the entire mission.

Each day, mating behavior should be completed within two hours after the transition from a 10-hour dark period to light period. After crew members visually verify the first spawning onboard Columbia, a video camera will record activity for the first two hours of the light period, which should be enough time to record the fish mating behavior.

Once spawning starts, the fish will continue to lay eggs once every day for a month. Newly laid eggs first form a cluster on the belly of the female fish. After a few hours, the eggs fall away from her body. The detached eggs should flow with the water into an area separated by a mesh structure. The crew will continue video observations of the developing embryos at predetermined intervals. Detailed observations of its early embryonic development are possible because the egg envelope is transparent. The fry are expected to hatch about eight days after spawning. Investigators expect to see hatched fry swimming in the aquarium during the mission. They also are interested in the swimming behavior of the fry and adults after Columbia lands.

Genetic studies of the fish will be conducted post flight. Computer analysis of fish movement based on the video images recorded on the ground and in orbit is also planned.

Applied Research on Separation Methods Using Space Electrophoresis
Recherche Appliquee sur les Methodes de Separation en Electrophorese Spatiale (RAMSES)

Payload Developer: The French Space Agency (CNES)

Objective: Scientists will conduct experiments using RAMSES to better understand the basic mechanisms that govern electrophoresis and assess gravity's impact on the process. Separating and collecting ultra-pure components of biological substances is an area of research with great importance to the pharmaceutical industry. Electrophoresis is a process for separating biological materials into individual components using an electrical field. These purified materials can then be used for other processes, such as growing crystals. This technology has been adapted for use in microgravity in the RAMSES electrophoresis unit. RAMSES is the French acronym for Applied Research on Separation Methods using Space Electrophoresis. This multi-user facility was developed by the French Space Agency in conjunction with European industrial partners.

Gravity-induced fluid movements such as sedimentation (settling of heavier elements in the solution) and convection (flows within fluids caused by temperature and concentration differences) tend to remix the compounds during separation on Earth. RAMSES will allow researchers to escape these limits by taking advantage of the reduction of gravity-induced phenomena in space.

The basis of the electrophoresis separation process is complex. Biological molecules in a fluid carry electric charges. Each type of molecule moves within an electric field at different speeds depending on its charge polarity, size and shape. For example, a molecule that is very negative will feel greater attractive and repulsive forces from the electric field than a slightly negative particle. Consequently, it will move more quickly than the molecule possessing less charge. The fluid in which the particles are suspended also plays a role in this process. The viscosity of the fluid or carrier solution hinders the forward movement of large molecules.

With the virtual absence of convection and sedimentation in microgravity, other important phenomena normally masked by gravity come into play, affecting the separation of molecules. Scientists are particularly interested in these electro-hydrodynamic effects. These are rotating movements of the liquid that are produced by the electric field.

Hardware and Operations: RAMSES is a continuous flow electrophoresis unit, meaning the biological sample to be purified is continuously injected into a carrier solution flowing up the length of a transparent separation chamber. An adjustable electric field is applied across the flow, causing the differently charged components to diverge into a wide beam consisting of separate streams. The separated streams of molecules pass through 40 outlets into collection tubes. A light absorption instrument, called a photometer, monitors the process. When it detects a significant concentration of biological material in the outlet flow, crew members will recover those collection tubes which, after storage in a refrigerator, will be returned for analysis. Otherwise the flow is diverted to a waste tank.

Separation parameters -- flow rates, electric field strengths and carrier fluid temperature -- can be altered to study a wide range of conditions. This will allow the optimum separation conditions to be determined. Crewmembers can monitor the separation experiments and photograph them through a transparent window in the instrument front panel. A specialized light source provides a "sheet" of illumination across the separation chamber, producing a cross-sectional view of the sample flow behavior.

The RAMSES Control Command and Acquisition System directs the operation of the complete system. It provides the user interface, acquires and stores experiment data, and provides connections with the science team on the ground. Crew members can also make adjustments. The crew will be responsible for setting up operations, monitoring the separation process and the photometer which indicates the collection tubes that are gathering the highest quality samples. These are the samples that will be returned to scientists on the ground for further research.

Optimization of Protein Separation

Experiment Facility: RAMSES
Principal Investigator:
Dr. Victor Sanchez
National Center for Scientific Research (CNRS) Chemical Engineering Laboratory
University Paul Sabatier, Toulouse, France

Objective: This investigation will use a unique process to separate protein solutions into individual components using an electric field. The process is called electrophoresis. Solutions of proteins will be purified by separating them into several streams, each one containing proteins of only one kind. Just one milligram (a thirty thousandth of an ounce) of protein purified for use in pharmaceuticals can be very expensive. Performing this purification in the absence of gravity may allow scientists to gather purer protein in larger quantities than is possible on Earth.

Two series of experiments will be conducted to evaluate the degree of protein purification that is possible in microgravity. Three samples each contain two pure proteins that have been mixed together. This will allow the process to be tested with well-known products. Three other samples contain a great number of proteins extracted from a bacterial culture. Here most of the proteins are unidentified, and scientists are interested in how these solutions will separate. Another objective is to test whether the biological activity remains intact in the purified product.

Science: A protein molecule is a complex structure that has an electric charge. Each type of protein moves at a different rate across the chamber when exposed to an electric field. Therefore, when a solution of protein molecules is passed through a separation chamber, the molecules will move away from the side with the same charge toward the opposite-charged side of the field. The particles will separate and fan out into an array of bands as they flow through the chamber. At the outlet they can be collected for further research.

The principal investigator's team hopes to study a three-fold combination of effects:

• how the separation process is affected by the strength of the electric field and by the length of time spent traveling through it

• how the protein molecules interact with ions and molecules of the carrier solution

• electro-hydrodynamics, a rotating movement of the carrier liquid caused by disturbances in the electric field due to the presence of the protein.

Significance: Tomorrow's pharmaceuticals will be developed using proteins produced by biotechnology. Therefore, scientists require a precise knowledge of protein structure. To obtain this, highly purified protein molecules are necessary in sufficient quantity to allow protein crystals to be formed.

Working in microgravity eliminates buoyancy forces, allowing scientists to use more highly concentrated protein solutions, higher electric field strengths and slower carrier flow rates for longer separation times.

Background: IML-2 scientists will build on past progress with continuous flow electrophoresis operations in microgravity by studying a variety of biological materials and further characterizing this type of processing and the operating conditions that affect it. Investigations into electrophoresis for separating biological materials began in the 1950s. McDonnell Douglas Corp. conducted several experiments onboard the Space Shuttle during the 1980s. This French team of investigators became interested in this process in the mid-1980s.

Operations: In continuous-flow electrophoresis, a stream of carrier solution flows through a thin, rectangular chamber. When a protein mixture is injected into this flowing solution, it moves with the flow and an electric field causes the proteins to move apart across the width of the chamber. A direct current field is used here to keep the proteins always moving in the same direction. A photometer (measuring light absorption) will be used during operation for measuring protein concentrations in the 40 samples. A crew member will refrigerate the samples with the highest protein concentrations, which will be returned for post flight analysis. The first sample to be treated will contain two colored proteins. These are easily separated and will be processed under the same conditions as on Earth. This will demonstrate that the instrument is operating correctly on its maiden flight. This instrument can treat up to one milligram of protein per hour, which is considered a large amount of matter.

Electrohydrodynamic Sample Distortion

Experiment Facility: RAMSES
Principal Investigator:
Dr. Robert Snyder
NASA Marshall Space Flight Center
Huntsville, Ala.

Objective: This experiment focuses specifically on electro-hydrodynamics. This is the movement of liquid driven by an electric field. In this case, the movement will be made apparent by the use of a suspension of latex particles in liquid. Scientists will examine how the shape of a stream of particles is modified by an electric field.

Electro-hydrodynamic effects are more easily observed in the absence of gravity, where convection caused by buoyancy is virtually eliminated. Sedimentation, the settling and separation of heavier elements from lighter ones, also is greatly reduced. The principal investigator's team plans to stop the flow of a carrier liquid and immobilize the stream of latex particles. On Earth, the particles would immediately settle to the bottom of the chamber. In microgravity, the originally cylindrical stream of particles should be deformed by the electric force without interference from any other movement.

Significance: Continuous-flow electrophoresis is a process that allows protein mixtures, or living cell populations, to be separated into batches of highly purified products in sufficient quantity for them to be used in other processes, such as protein crystallization.

However, before highly concentrated samples can be processed on a large scale, the factors governing electrophoresis must be more fully understood. One is the electro-hydrodynamic spreading of a sample stream in electrophoresis, resulting in remixing of the components that are meant to be separated, thus harming the purity of the product.

Improved understanding of the physics underlying electro-hydrodynamics will help scientists better control this phenomenon and thereby improve the separation in electrophoresis. Microgravity allows highly concentrated samples to be used and observations to be made even when the carrier flow is entirely stopped.

Science: Latex particles are bigger and less complex in structure than protein molecules so they are easier to study. Like proteins, the latex particles retain a positive or negative charge. This means that they also can be influenced by an electric field.

The electric field around a stream of latex particles can be distorted either by varying differences in electrical conductivity or by using differences in dielectric constant. The manipulation of electrical conductivity in the liquid results in local areas through which electric current passes more easily, and areas of greater opposition to current flow. The result is a non-uniform field in the liquid.

The dielectric constant involves the way in which molecules or particles tend to be oriented by an electric field. A non-uniform field causes the liquid in and around the latex-particle stream to rotate, showing up as a change in shape of the stream of particles.

Background: Electro-hydrodynamic effects such as these were originally observed in the 1960s. Previous continuous-flow electrophoresis experiments exhibited electro-hydrodynamic spreading of the sample stream when electrical properties (such as conductivity and dielectric constant) of the sample stream were not the same as those of the carrier solution.

Operations: Two different samples will be used to study the effect of varying the latex-particle concentration. The suspension of latex particles will be injected into a carrier solution flowing through the separation chamber of the RAMSES electrophoresis unit.

The first part of this experiment uses AC fields, in which the positive and negative poles of the field are rapidly switching. The latex particles should not exhibit any net movement, allowing the electro-hydrodynamic effect itself to be observed. As the solution flows through the chamber it should widen into a continuous ribbon of latex particles. A thin sheet of light will illuminate a cross-section of this ribbon so that a crew member may view and photograph any distortions to the flow of latex particles.

Advanced Protein Crystallization Facility

Payload Developer: European Space Agency

Objective: Advanced Protein Crystallization Facility (APCF) research has two objectives: to provide difficult-to-produce, biologically important protein crystals for analysis, and to determine the physical mechanisms that govern protein crystal growth. It is the first space facility ever designed to use three different protein crystal growth techniques.

Significance: Proteins are complex molecules responsible for a great many biochemical functions essential to life on Earth. Scientists strive to determine the structure and function of proteins to better understand living systems and to develop medicines. For example, the pharmaceutical industry uses structural information to design drugs which bind to a specific protein, blocking chemically active sites. Such a drug fits a protein like a key in a lock to "turn off" the protein's activity, thus regulating metabolic processes.

The three-dimensional structures of proteins are determined by X-ray analysis of protein crystals. However, many proteins that interest medical researchers have not produced crystals of adequate size and quality to allow X-ray data to be collected. Crystals grown in space, where they are virtually free from the distortions of gravity, often provide better structural information than their counterparts grown on Earth.

Hardware: The Advanced Protein Crystallization Facility is a fully autonomous facility except that it requires electrical power from the Shuttle and activation by a crew member when orbit is reached. Temperature control, any value between 4 and 25 degrees C is possible, activation/deactivation of the protein growth chambers, monitoring of basic housekeeping parameters, video image taking and recording of all data on a digital tape recorder are performed under control of a microprocessor. Two experiment units exist, each of which occupies one Shuttle mid-deck locker. For IML-2, both units will be held at a constant temperature of 68 degrees Fahrenheit (20°C). Each unit can accommodate 48 modular protein crystal growth chambers, 12 of which can be observed with a high-resolution, black and white video camera. Chambers for each of the three crystallization techniques are available in different volumes. All types and volumes of chambers are interchangeable within the units, so researchers can choose the best combination for their particular studies.

The three protein crystallization techniques available to users of the facility are:

Vapor diffusion: The protein is suspended as a drop at the end of a syringe tip in a chamber surrounded by material soaked in a concentrated precipitation agent. As water migrates from the protein solution to the precipitant solution, the concentration of protein within the drop increases. Eventually, it supersaturates, and crystal growth begins.

Liquid-liquid diffusion: The protein solution, a buffer solution, and a precipitant solution are initially separated by shutters. When the shutters are removed, the precipitant diffuses through the central buffer solution into the protein solution, causing the protein to become less soluble and initiating crystal growth.

Dialysis: The protein solution is separated from a reservoir of precipitating agent by a thin membrane of material that allows passage of some substances while blocking others. The precipitant moves across the membrane into the protein solution, initiating crystal development.

Operations: The crew activates the Protein Crystallization Facility after reaching orbit, monitors the facility as it operates, and deactivates the equipment when experiments end. No data are transmitted to the ground during the mission.

Crystal growth begins by causing a protein solution to "supersaturate," a condition where more protein is present than can remain dissolved within a volume of fluid. As a result of this supersaturation, the protein crystals precipitate out of solution and begin to grow.

Video images will be made of crystals as they form. After the mission, the approximately 5,000 images will allow investigators to study the history of crystal development in microgravity.

Background: This experiment facility was developed by the European Space Agency. It has flown once before, on the Spacehab-1 mission (STS-57) in 1993.

Principal Investigator	Proposed Protein(s)	Method
N. Chayen/P. Zagalsky Great Britain	alpha Crystacyanine	vapor diffusion
A. Ducruix/M. Ries	Collagenase diffusion	vapor
CNRS Laboratory of Crystallography Gif sur Yvette, France	Rhodobacter Spheroides	liquid- liquid diffusion
V. Erdmann/S. Lorenz Free University of Berlin Berlin, Germany	RNA	vapor diffusion dialysis
R. Giegé/A. Théobald CNRS Institute of Molecular and Cellular Biology Strasbourg, France	Aspartyl-tRNA Synthetase	vapor diffusion dialysis
W. deGrip/J.V. Oostrum University of Njimegen Nijmegen, The Netherlands	Rhodopsin	vapor diffusion
J. Helliwell/E. Snell University of Manchester Manchester, England	Lysosyme (collaboration with Sjölin)	dialysis
J. Martial/L. Wyns Belgium	Octarellin Copperoxalate liquid- liquid diffusion, dialysis	vapor diffusion
A. McPherson/S. Koszelak U. of California at Riverside Riverside, California	Satellite Tomacco Mosaic Virus Satellite Panicum Mosaic Virus Cucumber Mosaic Virus Turnip Yellow Mosaic Virus	liquid- liquid diffusion
L. Sjölin Chalmers U. of Technology Göetborg, Sweden	Ribonuclease S (collaboration with Helliwell)	vapor diffusion
G. Wagner Justus-Liebig U. of Giessen Giessen, Germany	Bacteriorhodopsin	dialysis

Principal Investigator	Proposed Protein(s)	Method
A. Yonath/H. Hansen Max-Planck-Laboratory for Ribosomal Structure Hamburg, Germany	Haloarcula marismortui 50S	vapor diffusion
F. Jurnak U. of California at Riverside Riverside, California	Pectate lyase liquid	liquid- diffusion
M. Garavito University of Chicago Chicago, Illinois	OmpF porin	liquid- liquid diffusion
K. Ward Naval Research Laboratory	Aequorin Phosphoilpase A1 Green fluorescent protein	liquid- liquid diffusion
H. Einspahr Bristol-Meyers-Squibb	Cytochrome c (tuna)	liquid- liquid diffusion
P. Weber DuPont	Alpha-thrombin (human)	liquid- liquid diffusion

Bubble, Drop and Particle Unit

Developed by the ESA

Objective: Subtle aspects of fluid physics, normally hidden by the effects of Earth's gravity, will be investigated in microgravity with the Bubble, Drop and Particle Unit, developed by the European Space Agency.

Researchers will study fluid behaviors and interactions such as bubble growth, evaporation, condensation, thermocapillary flows (fluid motions generated by temperature differences along the surfaces of liquids). Such phenomena are difficult to observe on Earth because their effects are masked by gravity-induced fluid movements.

Science: Our intuitive expectations of how fluids (liquids or gases) normally behave are based on their actions under the influence of gravity. For example, hot air rises because it is less dense than cooler air, and gravity's pull similarly induces convection -- flows within a fluid caused by density differences. Muddy water will clear when left standing because gravity also causes sedimentation (the separation and settling of heavier elements from lighter ones) of soil particles suspended within the water.

In a microgravity environment, such gravity-driven convective flows are minimized, and other more subtle fluid movements, such as thermocapillary flows, can be observed. The flows become the main mechanism of heat transfer within fluids. Suspended particles, bubbles and liquid drops behave differently in microgravity. For example, drops of liquid become spherical, instead of teardrop, as their shape becomes dominated by surface tension effects instead of gravity.

Significance: Results may be used to improve the design of spacecraft life support and fuel management systems as well as materials processing both on Earth and in space. The behavior of fluids is at the heart of many phenomena in materials processing, biotechnology and combustion science. Surface tension-driven flows (fluid flow from hot regions to cold) affect semiconductor crystal growth, welding and the spread of flames on liquids. The dynamics of liquid drops are an important aspect of chemical process technologies and in meteorology.

Hardware: Crew members will exchange interchangeable experiment test containers with dedicated fluid cells located in the Bubble Drop and Particle Unit. The fluid cells can incorporate mechanical or acoustic stirrers for fluid mixing, injectors for bubbles or droplets, and heating and cooling elements to impose temperature differences within the fluid.

Modular optics components support several different diagnostic techniques, including Schlieren (shadowgraph), interferometric and infrared imaging. The sample can be illuminated using fluorescent lamps, or a Helium-Neon laser. Experiments are automatically controlled by a microprocessor. Investigators on the ground can monitor the processing of their experiments and can change parameters. Crew members can also adjust and modify conditions.

Cameras and sensors will observe and record temperature, density, position and interactions within the liquid-filled test cells.

Bubble Migration, Coalescence and Interaction with Melting and Solidification Fronts

Experiment Facility: BDPU
Principal Investigator:
Dr. Rodolfo Monti
University of Naples
Naples, Italy

Objective: Bubbles form as molten alloys, crystals and glasses begin to solidify both on Earth and in microgravity. Scientists are interested in why these bubbles are not uniformly distributed within the metal, whether processed on Earth or in space. This investigation will use a transparent material to observe the movement of bubbles at the liquid-solid interface as the material first melts, then solidifies. It also will study how drops of liquid behave when exposed to a temperature gradient and interact with the solidification front -- the moving boundary where a molten substance is crystallizing into solid.

Significance: This research is significant for improving techniques for material processing in space. It is important to learn how to control the movement of bubbles in a material during phase changes, such as from liquid to solid. Scientists are interested in knowing how to solidify materials, both with the bubbles included and excluded from the substance.

These findings have potential applicability for industries in areas such as the production of crystals in electronic devices. Another area of industrial interest is refining the capability to disperse one material into another with extremely high uniformity by controlling the Marangoni migration of inclusions in melts. This is the movement of bubbles or drops driven by surface forces when a liquid's surface tension is affected by heat, in the form of a temperature gradient.

Science: On Earth, gravity-induced convection and buoyancy alter processes that would benefit from gravity- and disturbance-free conditions. This experiment will allow scientists to observe bubble movement and the interaction with the solidification front in the absence of gravity with bubble-drop dimensions not achievable on the ground.

Operations: The test sample will be a solid piece of tetracosane, a transparent material that melts at a low temperature. The material sample includes pre-formed bubbles of different sizes.

The tetracosane will be heated above its melting point 131 degrees Fahrenheit (55 degrees Celsius). As the melting front reaches each bubble, the bubble will be released and is expected to migrate toward the hot side of the liquid, away from the melting front. The locations, dimensions and movement of the bubbles released by the melting front will be recorded. Other characteristics of the migration will be studied and documented.

Thermocapillary Migration and Interactions of Bubbles and Drops

Experiment Facility: BDPU
Principal Investigator:
Dr. R. Shankar Subramanian
Clarkson University
Potsdam, NY

Objective: This experiment will study the movement and shape of gas bubbles and liquid drops in silicone oil when a temperature gradient is established within the container. The bubbles are expected to move from a position near the cold wall toward the hot wall. The gas bubbles and liquid drops will have a range of diameters and densities.

Significance: Bubbles and drops are encountered in various materials processes, such as solidification and preparation of composite materials. Also, for long-duration space voyages, recycling of waste material will be essential, and separation processes used for this purpose may involve bubbles and drops. Therefore, it is important to understand the motion of bubbles and drops and to learn to manipulate them under low-gravity conditions where buoyancy is negligible.

Science: Bubbles do not behave in space like they do on Earth. By managing bubbles and drops and measuring how fast they move because of a temperature difference, scientists may be able to predict various engineering applications and hardware designs. This heating and cooling simulates the melting and solidification of metals and other basic scientific principles used in other experiments.

The investigator's team will study how fast the bubbles move, their size and shape. These data will be compared with mathematical predictions.

Operations: A series of experiments, each lasting about four hours, will be conducted. Before each series, a temperature gradient will be established in the container. Thereafter bubbles and drops will be injected into a small rectangular cell filled with a fluid. Approximately six bubbles (or drops) will be injected in sequence. Their motion will be monitored on the ground via video. Then, the bubbles or drops will be extracted through an extraction net, in preparation for the next series of runs. Results from the experiments will be compared with predictions from theoretical models. Temperature control and bubble/drop injection can be performed automatically and under control of the investigator on the ground or by an IML-2 crew member.

Bubble Behavior Under Low Gravity

Experiment Facility: BDPU
Principal Investigator:
Dr. Antonio Viviani
Seconda Universita degli Studi di Napoli (SUN)
Aversa, Italy

Objective: This experiment investigates how different size bubbles of inert gas move within a liquid. The liquid, n-heptanol, will be subjected to an uneven temperature distribution. The membrane encasing the gas bubble will react to the temperature variation within the liquid. The membrane toward the colder temperatures contracts -- a result dependent on a surface tension change on that portion of the membrane -- causing the bubble to move.

The motion of the bubbles is driven by variations in the surface tension, which are induced by temperature differences along the interface (thermocapillary effect), between the liquid and the bubble. This particular kind of liquid permits measurement of an unusual, non-linear temperature-dependent surface tension. The fluid region where surface tension is at a minimum is of great interest.

Science: This phenomenon can be illustrated with an analogy. Soiled clothes are washed in hot water which relaxes the surface tension of the cloth fibers permitting the dirt to be extracted. This investigation will use temperature differences and thermodynamic principles to move and extract bubbles. Scientists also want to determine if higher temperatures will cause bubbles in molten glass to migrate to an exterior surface so they can be eliminated.

Significance: Earth's gravitational field acts on density differences between air and liquid, making buoyancy forces predominant. In the absence of gravity, density is eliminated and only the effects of surface tension are observed. The effects of this phenomenon on Earth are masked by buoyancy. In space, scientists can observe how bubble movement is affected solely by surface tension to gain a better understanding of the role surface tension plays on Earth.

Operations: Bubbles of inert gas will be injected into the liquid n-heptanol under a temperature gradient. Investigators will determine the non-uniform velocity of the injected bubbles for different temperature ranges. They want to observe the behavior of the bubbles when they reach the center of the container where the surface tension will be at a minimum and the bubbles are expected to stop.

The experiment will be repeated with several bubbles of varying size. The temperatures of the chamber walls will be varied. Sometimes the bubbles will move toward the hotter chamber wall. At other times they will move toward the cold wall.

The investigators also plan to inject two bubbles to observe what happens when they come together. Images of the bubble migration will be recorded and sent to investigators on the ground. The experiment sequence is three-fold: establish optimal temperature conditions, inject bubbles, and extract the bubbles using a net mechanism.

Interfacial Phenomena in a Multilayered Fluid System

Experiment Facility: BDPU
Principal Investigator:
Dr. Jean N. Koster
University of Colorado
Boulder, Colo.

Objective: Even in everyday life, we frequently observe that some fluids, such as oil and water, do not mix. Instead, they form layers when placed in the same container. This investigation is designed to study what is happening at the place where the immiscible liquid molecules touch each other, called the liquid-liquid interface, when temperature-driven fluid motion is generated at the contact surface. The experiment will be conducted using a multilayered immiscible fluid system.

Science: Studying interface forces in low gravity will provide new and fundamental insight into a complex field of fluid physics that cannot be studied on the ground. Earth's gravity causes liquids to move convectively upward and downward when a temperature difference is generated across the surface of a liquid. So, in order to isolate and study fluid motion caused by temperature variations along the surfaces of fluids (thermocapillary motion), it is necessary to escape gravity's effects.

The interface tension-driven flow where the molecules of the different liquids interact is a complex process. An industrial interest in this process developed when investigators became interested in liquid-encapsulated crystal growth, where one liquid is processed while enveloped in another liquid. For example, gallium arsenide, a useful semiconductor material, has been grown using a liquid encapsulation technique to keep the arsenide, a toxic substance, from escaping.

Significance: This experiment will help scientists to better understand thermocapillary fluid physics. Physicists wanted a crystal growth furnace where the heating would not create convective flows, especially time-dependent flows, in the molten metal. Scientists believe this type of furnace, with liquid encapsulated electronic melt, could improve crystal growth in microgravity by reducing or eliminating the thermocapillary motion in electronic material.

Findings from this experiment will benefit research in other areas, including environmental science, geology, advanced aerospace materials development and future space power systems.

- Environmental scientists are interested in learning about the interaction between oil and the water it is floating on. Understanding immiscible fluid flows is of value for cleaning up environmental water pollution caused by oil spills.

- An interesting geological application will use this knowledge to study the Earth's mantle. Two convecting, adjacent layers have an interface that physically behaves in the same manner. Computer models are used to examine tectonic movement.

Operations: A special test container was developed for this experiment and that of Dr. Legros. Three fluids which do not mix are used to establish two liquid-liquid interfaces in this three-layer system composed of fluorinert, silicone oil and fluorinert. Until the experiment is begun on orbit, the three fluid layers are separated by two metal curtains in the container. At the initiation of the experiment these curtains will be retracted. Using temperature variations, fluid motions are initiated at the two liquid-liquid interfaces, such that motion at one interface competes with the other. Temperature-driven flow throughout all three fluid layers will be visualized using tracers inside the liquid.

Scientists on the ground will observe the behavior of the interfaces. For example, they will be able to study the interdependent interactions between the individual layers due to temperature gradients. These data will be compared with computer model results and will subsequently help validate the mathematical models. Findings will provide a better understanding of the underlying physics involved in these processes.

Thermocapillary Instability in a Three-Layer System

Experiment Facility: BDPU
Principal Investigator:
Dr. Jean-Claude Legros
Free University of Brussels
Brussels, Belgium

Objective: Surface-tension forces within three layers of fluids will be studied. The investigator's team wants to learn how to control fluid flows within the middle layer.

Significance: Understanding these complex types of fluid flows and finding ways to control them are significant to the field of material science, particularly the specialized field of directional solidification. Directional solidification is a method for growing crystalline materials such as metals and semiconductors. In this technique, molten material is cooled so that the boundary between solid and liquid material moves from one end towards the other during solidification. It is this boundary region that is particularly significant to researchers.

Science: This experiment, along with Dr. Koster's investigation, is expected to provide the first information on the departure from the rest state of a multi-layer system under the influence of surface-tension forces. Using these findings, scientists should be able to devise ways to counteract or eliminate some of the undesirable effects of surface-tension forces in space.

The basic mechanisms which cause these types of flows are understood, but not the means for effectively controlling them. This type of control becomes highly desirable when, for instance, researchers want to create flawless silicons and metals for the electronics industry.

Operations: Experiment procedures will allow scientists to describe quantitatively the convective pattern arising in three layers of immiscible liquids, fluorinert, silicone oil, and fluorinert. The experiment will be conducted in a test container identical to that used in Dr. Koster's experiment. Curtains inside the cell, separating the three layers, will be retracted and heat will be applied. Heating sources above and below the liquid layers are used to create a temperature gradient that is perpendicular to the two liquid-liquid interfaces established between the fluids.

When set temperatures are reached and stabilized, video and infrared images of the convective motion are downlinked to investigators on the ground. This phase is repeated several times with different thermal gradients.

Nucleation, Bubble Growth, Interfacial Micro-Layer, Evaporation and Condensation Kinetics

Experiment Facility: BDPU
Principal Investigator:
Dr. Johannes Straub
Technical University of Munich
Munich, Germany

Objective: This experiment is designed to provide a better understanding of boiling processes. It uses vapor bubbles within a liquid to study the process of evaporation and condensation at a liquid interface, the point where a liquid phase of a fluid forms a common surface with its vapor phase.

Science: Evaporation occurs when a liquid changes to a gas due to increased heat. Condensation is the reverse process, when the gas cools to a liquid.

Scientists will create a small gas bubble in an evenly heated, liquid refrigerant. The bubble will become larger as it draws heat from the liquid, until the temperatures of the liquid and gas reach a state of equilibrium.

Scientists will study physical changes during evaporation and condensation at the interface where the bubble contacts the liquid. In Earth's gravity, bubbles disappear very rapidly from the field of view, hindering such studies. In microgravity, the vapor bubble will remain where it is formed and grow in size, making it easier to observe.

Significance: Evaporation and condensation at liquid-gas interfaces are fundamental processes in our lakes, seas and rivers. The processes also have technical applications in heat exchangers, energy conservation systems and the chemical industry. A precise knowledge of the kinetics, or energy processes, which govern boiling, is important to understanding environmental effects and improving technical systems.

Background: The science team has conducted this experiment in the brief weightless conditions available during parabolic flights with a specialized Caravelle aircraft, a drop tower and a sounding rocket flight. However, this will be its first time in orbit.

Operations: A crew member will place a sealed aluminum container filled with Freon into the Bubble, Drop and Particle Unit. Heaters within the container will warm the refrigerant evenly from all sides. A compressor will increase pressure in the container to remove any air bubbles which may exist in the liquid, then reduce pressure so the liquid will reach a supersaturated state, where it remains liquid at a temperature above that at which it would normally become a gas.

Then, experiment scientists on the ground will command a short heat pulse from a spot heater, which will create a gas bubble inside the liquid. The bubble will draw heat from the supersaturated liquid and continue to expand until the gas and liquid reach equilibrium. Cameras and sensors will observe and record temperature, Freon density, and positions of the bubble. After each phase of the experiment, controllers will increase the pressure to condense the bubble.

They will repeat the experiment at six different heat levels, between room temperature and approximately 185 degrees Fahrenheit (85 °C).

Static and Dynamic Behavior of Liquid in Corners, Edges and Containers

Experiment Facility: Bubble, Drop and Particle Unit
Principal Investigator:
Dr. Dieter Langbein
ZARM Institute
Bremen, Germany

Objective: This experiment will record the behavior in microgravity of liquid surfaces, making precise measurements of the angles where liquids and solid surfaces meet.

Science: In a weightless environment, liquid movements due to gravity are minimized, allowing for observations of more subtle fluid dynamics, such as thermocapillary flows. This type of liquid movement becomes the main mechanism of heat transfer within fluids. During IML-2, this fluid investigation will confirm the existence and stability limits of liquid surfaces in a cylinder.

Significance: This experiment will give scientists insight into the wetting phenomena caused by capillary forces. The data collected during this experiment will also help design better surface-tension tanks (tanks that provide fuel at the outlet valve via capillary effects alone, without relying on gravity or pistons).

Equipment and Operation: Silica Matched Liquid Cargille 50350, a liquid which has the same refractive index as quartz, will be injected into the quartz test cell of the Bubble, Drop and Particle Unit. This test cell, which contains four different transparent, polygonal cavities with different wall angles, will be maintained between 68 and 175 degrees Fahrenheit (20 and 80 degrees Celsius), using heaters situated between each cell. The surface shapes produced as the temperature and liquid volumes are changed will be observed using background and cross-section illumination.

Background: IML-2 is the first on-orbit flight for this experiment. Previously, this investigation was conducted from sounding rockets launched in Sweden and inside a drop tower in Germany.

Critical Point Facility

Developed by: European Space Agency (ESA)
European Space Research and Technology Center
(ESTEC) Noordwijk, The Netherlands

Objective: Several experiments will be able to measure and visually record special fluid properties at their "critical point" with the Critical Point Facility, developed by the European Space Agency.

At the critical point, a fluid is neither a gas nor a liquid, it is both; more precisely, the material fluctuates back and forth in small volumes from one state to another so that the state of the total volume is indistinguishable. Scientists have been unable to study this interesting behavior closely in normal gravity.

In Earth's gravity, critical point experiments are difficult to perform due to the fluid being very compressible. Most of the sample cannot be maintained at the critical density because the fluid's own weight compresses part of the sample to a density greater than the critical density. The most critical region literally collapses under the weight of the fluid.

Significance: Critical point phenomena are common to many different materials. Understanding how matter behaves at the critical point can provide insight into a variety of physics problems ranging from phase changes in fluids to magnetization changes in solids.

Information gathered from these experiments refines the physical theories that describe the mechanism and the rate of change of fluid states.

Background: On Earth, gravity blocks experimental efforts in working with pure fluid critical-point systems. The feverish experimental activity of the 1960s and 1970s in critical phenomena slowed in the 1980s partly because of gravitational limitations on the acquisition of experimental data closer to the critical temperature. However, some unexpected observations of near-critical fluids in low gravity have encouraged the study of equilibration dynamics with new enthusiasm in critical phenomena research.

Hardware Description: The facility is a multi-user system capable of accommodating the experiments of several researchers sequentially in any one mission. Interchangeable thermostats for controlling the temperature of an experimental sample are inserted in the facility, where they are surrounded by an optical diagnostics system to monitor the phenomena of interest.

Temperature is extremely important in critical point experiments. So, the facility was designed to provide extremely accurate thermal control of the test fluid.

The CPF hardware is composed of two interconnected drawers: the electronics and the experiment drawers.

The front panel of the electronics drawer allows the crew to manipulate the experiment via an alphanumeric key pad display, switches and lamps.

The experiment drawer contains a front panel access door through which different experiment thermostats can be inserted for processing.

A black and white video camera is a useful tool in the apparatus. This camera is used to monitor fluid dynamics of the sample when it undergoes temperature cycling during an experiment. A 35mm camera is attached to the front of the experiment drawer for still photos. A laser and a light emitting diode, which serve as light sources for the experiment also are located inside the drawer.

The facility will measure density fluctuations near the critical point through the use of laser light scattering and interferometry. Interferometry splits and subsequently reunites beams of light after they travel different paths. The two separated beams interact (interfere) with each other in such a way as to allow precise measurement of very small distances and thicknesses. These data show the local fluid density changes in various parts of the cell.

Operations: The sample fluid held near its critical density is housed within sealed cells. The cells are installed in a high precision thermostat which holds them at a temperature between 86 and 140 degrees Fahrenheit (30 and 60 degrees Celsius). As the sample approaches its critical pressure and temperature from above, the normally clear gas becomes opalescent (cloudy) as it passes through the critical point. On Earth, this change takes place within a matter of seconds. In microgravity, the change happens uniformly over minutes, permitting scientists to gather large amounts of data.

Unusual density fluctuations occur at the critical point. These fluctuations strongly scatter the light and reduce its intensity. Detectors measure these variations. After the critical point has been crossed, these fluctuations diminish, and the sample forms patches of either liquid or gas phases.

Intermittent television video is available to investigators on the ground. Operators also gather nearly full-time digitized video snapshots at six-second intervals of the phenomena in progress. Once activated on orbit, the facility can operate in a fully automatic mode. Experiments are then conducted according to a prerecorded timeline. During the mission, however, the investigator's team can send remote commands to modify their experiments in real-time after analyzing optical, thermal and pressure data received at Spacelab Mission Operations in Huntsville, Ala. More than 1,100 such commands were sent successfully during the first flight of the CPF on IML-1, during some 120 hours of continuous operation.

The Piston Effect

Experiment Facility: CPF
Principal Investigator:
Dr. Daniel Beysens
CEA Department of Condensed Matter Physics
Gif sur Yvette, France

Objective: This investigation explores a specialized field within fluid physics. A hot layer within a contained volume of fluid is generated and expands and heats the rest of the fluid in a way somewhat similar to compressing it with a piston. This unique phenomenon by which a particular temperature can become uniformly distributed throughout a container of fluid has been given the name, the "piston effect". The effect arises only in fluids when they are at or near their critical point, and therefore highly compressible, or elastic. Such highly compressible fluids can be easily compressed into a given amount of space. One result is that they are very sensitive to thermodynamic effects.

As part of this experiment, the principal investigator's team is interested in what will happen to the pressure within the sample cell during two Space Shuttle maneuvers, which submit the test cell and fluid to a weak, controlled acceleration.

Science: When a substance is brought to its critical point condition and then heated beyond it, it has unique characteristics for a fluid and is said to be "supercritical." In this condition, one attribute of the substance is unusually high compressibility, or elasticity. A related property is that the fluid can exhibit very rapid transmission of heat through a type of flow similar to convection, but not caused by gravity. In fact, this type of transmission appears somewhat similar to the way sound waves travel through a fluid.

For a small fluid container, this piston effect form of heat transport occurs at a typical time range of between a hundreth of a second and 30-50 seconds, depending on the temperature relative to the fluid's critical temperature. This can be compared to "acoustic time," based on the velocity of sound -- which is in the range of only a few microseconds -- and "diffusion time," which is on the order of hours or even days for a substance near its critical temperature. The typical time for the piston effect is much longer than acoustic time, but shorter than diffusion time. It is a significant property because this is the time at which thermalization occurs. Thermalization, the process of a local temperature change becoming uniformly distributed, for a supercritical fluid occurs at the typical time for this piston effect.

Significance: This research has potential to help us understand the effective management of fluids used in fuel cells and rocket propulsion tanks.

Another expanding field of study uses supercritical fluids in industrial extraction processes, because the supercritical fluids are remarkable solvents.

Background: Recent numerical simulations and experiments on sounding rockets, the first Spacelab International Microgravity Laboratory mission, and the MIR space station have demonstrated the existence of the thermocompressible transport of heat, but scientists still know very little about the characteristics of this effect.

Operations: A number of experiments will be performed to determine the temperature, density, and pressure evolution using a temperature sensor or a laser beam as a local heat source. For this experiment, two fluid samples in the same thermostat will be studied simultaneously over a 43-hour period.

Thermal Equilibration in a One-Component Fluid

Experiment Facility: Critical Point Facility
Principal Investigator:

Dr. Richard A. Ferrell
University of Maryland
College Park, Md.

Objective: This experiment is designed to study the critical-point properties of a fluid composed of identical molecules. At the critical temperature, there is no distinction between the liquid and the gas. The two phases become indistinguishable.

During these phase changes, energy is received and released by either heat diffusion or subjecting the substance to pressure changes -- a form of work. Heat diffusion occurs very slowly near the critical point, while pressure changes (the mechanism of imposed work) happen rapidly within the fluid. Studying how these two energy-transfer mechanisms interact is the goal of this experiment.

Significance: While it is of fundamental scientific importance, this experiment will also provide results of importance to other low-gravity, critical-point experiments now under development. In order for researchers to plan the timelines for these experiments, it is necessary to determine how quickly their test samples will reach thermal equilibrium after temperature step changes near the critical point.

Science: Any pure fluid possesses a liquid-vapor critical point where liquid and vapor are no longer distinguishable. The fluid also is highly compressible. This compressibility is the root of difficulties posed by gravity, when attempting to study critical point phenomena. At a given temperature, the critical zone is too small on Earth to measure. But the absence of gravity reduces the weight of the fluid on itself and widens the critical zone for a given temperature, allowing scientists to maintain critical point conditions over a large enough region to allow studying the critical behavior in detail.

Background: The first thermal equilibration experiment flew on the first International Microgravity Laboratory mission in 1992.

Operations: The investigation has two experiments, each made up of two parts. One experiment is called "thermal equilibration-B." It studies thermal transmission by the diffusion process, by setting up a steady heat flow across the cell, using a small heater attached to one side. Interferometry and light scattering will again be used to track the time evolution of density and temperature.

The second, "adiabatic fast equilibration," studies how "pressure work" transports energy from one part of the test cell to another. Temperature changes will be induced both externally, by changing the temperature of the confining windows, and internally, by heat from a pulse of current passing through a resistance wire inside the cell.

When the wire is charged to a static potential of up to 500 volts, the sulfur-hexafluoride in the cell is pulled into the electric field around the wire, causing a local density change observable by an optical technique known as interferometry. The electric field allows for fast change of cell conditions without heat input. This is a unique way to study diffusion in non-critical fluids.

This investigation will be conducted with the fluid sulphur-hexafluoride. The thermostat for each experiment will hold two fluid cells with a layer of fluid about a sixteenth of an inch thick (1 or 2 mm) confined between transparent windows at the proper critical density. One cell will be for interferometry measurements and the other for visualization.

The response of the fluid in both thermostats will be monitored visually with a video camera as well as by interferometry and light scattering. Interferometry gives information on the local fluid density changes in various parts of the cells. Light scattering becomes more intense near the critical point. Therefore, it is a sensitive measure of temperature changes.

Density Equilibration Time Scale

Experiment Facility: CPF
Principal Investigator:
Dr. Hermann Klein
DLR Institute for Space Simulation
Cologne, Germany

Objective: The experiment is aimed at improved understanding of mechanisms by which heat flow and density stabilization occur in a fluid substance, particularly close to its critical point.

Science: Subjecting a fluid substance to any change, for instance a tiny addition of heat, results in effects such as the introduction of localized density variations. Assuming the system was previously in a stable state, this amounts to a temporary disruption, or imbalanced state. Then, a relaxation or smoothing-out process will occur as the localized differences dissolve and conditions adjust toward uniformity throughout the fluid. Scientists refer to such a process, which ends with the substance at stable conditions, as "equilibration." They are particularly interested in the detailed physical mechanisms by which such changes occur -- mechanisms which include thermal transport, or how heat is moved, and mass transport, or how matter is rearranged.

As an example of such a process, a fluid which is below its critical temperature consists of distinct gas and liquid phases. One can see a boundary, or meniscus, between the two. However, heating of the fluid -- causing it to pass through its critical temperature -- causes this visible boundary to disappear. The fluid has entered a new single-phase condition where the liquid and gas are indistinguishable. When conditions such as density and temperature have stabilized following the phase-change process, the fluid is homogeneous. Local imbalances will be present and the system will be in a non-equilibrium state until mass transport is able to achieve a balance among the areas of density in homogeneity. It takes time for the stabilization to occur; this time element is of particular interest to physicists.

An analogous situation occurs when a fluid sample is cooled from above to below the critical point. It starts as a single fluid phase and becomes separate, coexisting phases of gas and liquid with a distinguishable boundary between the two. However, it again takes time before the equilibrium densities of the two phases have become fully developed, and while this is going on, there is an associated redistribution of mass under way, or rearrangement of matter within the fluid.

Significance: The study of fluid systems is a fundamental area of physics and one of the key objectives in the fluid systems field is understanding of equilibration processes and times. Equilibration times are very significant for obtaining meaningful experimental results in the measurement of physical properties. Near the critical point, physical properties take on a remarkable nonlinear character, something which can only be fully assessed when equilibrium states and equilibration processes are thoroughly known.

This research is also expected to provide a better understanding of the behavior of fluids in rocket and spacecraft thruster reservoirs, of processes inside heat exchangers, and of cleaning methods involving fluids at high pressure.

Operations: Sulphur hexafluoride is also the sample fluid for this experiment, because it is chemically inert and reaches its critical point at moderate conditions. During experiment runs, the sample is subjected to precisely controlled changes of temperature, to produce subtle physical effects such as described above. In the Critical Point Facility, a laser beam is directed through the sample. The amount to which the light intensity diminishes after passing through the sample -- the degree of light attenuation -- is an indicator of how close the sample is to the actual critical point, and also permits observing the progressive stages from disequilibrium to equilibrium and vice versa.

Crew involvement in the experiment consists primarily of unstowing and installing the dedicated experiment thermostat and powering up the laser and camera systems early in the mission. They will perform specific steps to initiate the experiment and verify that data is being properly gathered. After that, a combination of programmed commands and ground control inputs are used to cycle the sample through experiment runs.

Heat Transport and Density Fluctuations in a Critical Fluid

Experiment Facility: CPF
Principal Investigator:

Dr. Antonius Michels
University of Amsterdam
Amsterdam, The Netherlands

Objective: This experiment will measure the propagation of heat within a fluid near its critical point.

Science: Fluids reach their critical point when a precise combination of temperature and pressure compels their liquid and gas phases to become identical and form one phase. In this unusual state, the properties of the fluids can be altered dramatically.

One process of interest to scientists is how heat is transported within a critical fluid. There are three fundamental mechanisms which transport heat: propagation of sound, thermal diffusion and adiabatic compression heating, which is heating where there is negligible external input or release of heat. The latter two mechanisms are the focus of this experiment.

With liquids and gases, thermal diffusion is predominant. However, it becomes slower and slower as the fluid nears its critical point. Since fluid becomes increasingly compressible as it approaches the critical point, the compression heating becomes dominant in the near-critical state.

On Earth, heat transport investigations are flawed by gravity-driven convection. This space-based experiment allows scientists to study the relative importance of thermal diffusion and adiabatic compression heating in a convection-free environment.

Significance: Critical fluids are useful in technical applications such as extraction processes, where materials are transferred from low density to high density with very little force. Manufacturers must accurately calculate the feasibility of the technique for their specific process. If they are only a few percentage points off in these calculations, the process could be too expensive or inefficient to be practical. A better understanding of how heat transport mechanisms are altered near the critical point is important to improve the accuracy of these calculations.

Knowledge gained from this experiment will also improve scientific understanding of fundamental fluid physics.

Operations: A sealed canister containing sulfur hexafluoride will be placed in the Critical Point Facility by a crew member. Pre-programmed computer commands will begin the search for the critical point, which will be achieved at a temperature between 113 and 115 degrees Fahrenheit (45 and 46 °C). The sample will be heated to about three degrees higher than the critical temperature, then it will be lowered step by step — two thirds of the difference, then two-thirds again, until the critical point is reached.

The experiment team will monitor density differences within the fluid via downlinked video images as the critical point is crossed several times. Motion of the density differences, along with readings from temperature sensors within the sample container, will tell them how heat is being transported. A remote team in Amsterdam will receive simultaneous video and data, which they will process for more accurate understanding of the experiment.

Background: Dr. Michels performed a different experiment in the Critical Point Facility during the 1992 IML-1 mission. It helped confirm the effectiveness of the experiment facility for space-based investigations.

Vibration Isolation Box Experiment System (VIBES)

Payload Developer: NASDA

Objective: The Vibration Isolation Box Experiment investigates the effects of so-called "g-jitter," disturbances caused by crew movement and experiment equipment operations in space laboratories such as Spacelab. The information will be useful for experiment systems sensitive to the quality of the microgravity environment.

The experiment will test the effectiveness of a box designed to isolate sensitive experiments from vibrations caused by g-jitter.

Significance: The IML-2 mission has been designed especially to provide the highest quality microgravity environment available in the Space Shuttle. However, it is impossible to totally eliminate all disturbances to such an environment. Crew movements, equipment operations and occasional thruster firings can disrupt the quiet low-gravity environment and may affect some science experiments.

The Vibration Isolation Box Experiment System will support two experiments to study how g-jitter affects natural fluid flows, diffusion and thermally driven fluid flows under microgravity.

Both experiments will be performed with and without a damping system, to see how well the isolation box counteracts the effects of g-jitter on sensitive microgravity experiments.

Experiment Hardware and Operations: This system consists of a lockable vibration isolation box, two experiment units and an acceleration measurement unit.

Experiment units are placed inside the vibration isolation box inner container. The container is attached to an outer frame by a visco-elastic damping material. When the damping system is enabled, it should isolate experiments inside the box from some of the movements which would otherwise disturb them. Windows in the experiment units and the isolation box allow experiment operations to be videotaped.

The system has an acceleration measurement feature, consisting of two accelerometer sensor heads and a recording apparatus. One is mounted within the isolation box inner container, and another is mounted in the system's exterior framework, allowing accelerations to be measured both inside and outside the isolation box. After the mission, scientists can compare the acceleration measurements with fluid movement recorded on videotape.

Background: This experiment system is provided by the National Space Development Agency of Japan. A similar system was flown as an avian egg container in Spacelab-J to protect the egg from launch vibration.

Influence of G-Jitter on Natural Convection and Diffusive Transport

Experiment Facility: VIBES
Principal Investigator:
Dr. Hisao Azuma
National Aerospace Laboratory
Chohu-shi, Japan

Objective: This experiment will measure the effects of disturbances on flow and diffusion in a liquid within the Shuttle. It also will study the ability of the Vibration Isolation Box Experiment System to isolate experiments from these disturbances.

Significance: Disturbances caused by crew movement and equipment operations, known as g-jitter, can interrupt the quiet microgravity environment needed for some space experiments. In most cases, these disturbances are unavoidable. Experience from previous missions has proved the value of having astronauts onboard a space laboratory to operate, observe and adjust experiments. Essential equipment operations, from the hum of experiment systems to the motion of the TV antenna that transmits signals to ground controllers, create disturbances as well.

This experiment will determine how much g-jitter influences natural convection and diffusion in a liquid, as it is heated from one side to create a fluid flow. The experiment will be performed with and without the isolation box damping system, to test how well the system counteracts g-jitter effects.

Operations: A crew member will set up the convection and diffusion unit inside the isolation box during a time when all seven astronauts are awake and active. The unit is a rectangular container filled with diluted salt water that includes indicator dye. Both the isolation box and experiment unit have observation windows.

One side of the container will be heated to create a temperature difference in the water. Flows caused by residual gravity in the Shuttle and g-jitter can be tracked by observing the colored dye, and live video of the fluid motion will be transmitted to ground controllers. The experiment then will be repeated with the isolation box suspended from the facility's outer frame with a visco-elastic damper. Scientists will evaluate how much the damping system protects the experiment from external disturbances.

The system's acceleration measurement system will record motion detected by its sensors for later comparison with the video.

Study on Thermally Driven Flow Under Microgravity

Experiment Facility: VIBES
Principal Investigator:
Dr. Masao Furukawa
NASDA Tsukuba Space Center
Ibaraki, Japan

Objective: This experiment studies the basis for a more efficient spacecraft thermal management system. It is planned to confirm the basic function of liquid transport mechanisms in space using the principle of differential vapor pressure.

Science: One method for managing excess heat is a two-phase fluid loop, which transports liquid that separates from the co-existing vapor in microgravity. This experiment will test the fluid-transporting characteristics of a device known as an accumulator — comparing its performance with and without a mechanism designed to damp, or check, vibrations created by motion within the spacecraft.

Two vessels inside the accumulator contain water and are joined by a small channel. Water in one vessel will be heated, and vapor pressure differences between the two chambers will cause the liquid to move toward the other side.

On Earth, the system works well because water vapor rises to the top of the heated chamber, displacing some of the water to the other side. In microgravity, however, factors masked by gravity on Earth like the tension on the surface of the fluid will play a significant role in separating the fluid flow.

Significance: The next generation of spacecraft will be larger, more complex to operate, and will generate more heat. Therefore, their thermal management systems must have greater heat acquisition and rejection capability and be able to transport waste heat over a long distance. This study helps develop fluid management technologies such as gas and liquid separation, liquid reorientation, or liquid transport. Experiment scientists consider it indispensable for developing a two-phase fluid loop system, considered to be a primary candidate for future spacecraft thermal management.

Results also will contribute to the design of fuel cells, power plants, and environmental and life support systems which require thermal management of liquids.

Operations: A crew member will place the accumulator inside the Vibration Isolation Box, then heat the fluid on one side to observe the transfer process.

One experiment run will be completed without the isolation box damping mechanism engaged. For the other run, the isolation box will be suspended from the facility's outer frame with a visco-elastic damper. Behavior of the liquid flow and two-dimensional vapor/liquid diffusion will be recorded on video during both runs. Scientists evaluate how much the damping system protects the experiment from external disturbances.

The system's accelerometer will record motion detected by its sensors for later comparison with the video.

Space Acceleration Measurement System (SAMS)

Payload Developer: NASA
Principal Investigator:
Mr. Charles Baugher
NASA Marshall Space Flight Center
Huntsville, Ala.

Objective: The Space Acceleration Measurement System (SAMS) instrument will monitor and record higher-frequency onboard accelerations and vibrations experienced in the Spacelab module during flight. After the mission, scientists for IML-2 microgravity investigations will compare these records with their own data to identify accelerations which may have influenced their experiments.

Significance: Many of the IML-2 experiments require a very smooth ride through space so their delicate operations will not be disturbed. To maintain the most stable environment possible, the Shuttle will fly most of the mission with its tail toward Earth. In this orientation, called a gravity-gradient attitude, the vehicle's position is maintained primarily by natural forces, reducing the number of orbiter thruster firings which disturb acceleration-sensitive experiments.

Even in a gravity-gradient attitude, though, accelerations caused by crew movements, equipment operations and occasional thruster firings can temporarily disrupt the quiet low-gravity environment and may affect microgravity science experiments.

Different kinds of disturbances show up at different frequencies. They are measured in terms of fractions of Earth's gravity. Accelerations at one frequency may interrupt one type of experiment but have no effect on others. By studying SAMS data, scientists can determine not only that a disturbance occurred but can be fairly certain what caused it. They can then make allowances for the disturbance as they analyze their experiment results.

Scientists' growing understanding of how various accelerations affect individual experiments is helping researchers improve equipment and procedures for future flights on the Shuttle and for Space Station operations.

Experiment Hardware and Operations: Three remote sensor heads, each measuring motion in three dimensions, are located near selected experiments within the Spacelab module. They measure accelerations as small as one-millionth of Earth's gravity. The signals are transmitted via cable links to a central control unit in the center aisle of the module, where they are amplified, filtered and converted to digital data for storage on optical disks. Each disk can store up to 400 million bytes of data.

The sensor located near the Bubble, Drop and Particle Unit measures frequencies in the range of 10 Hertz, the sensor next to the Critical Point Facility measures frequencies of about 5 Hertz, and the one near the Electromagnetic Containerless Processing Facility measures frequencies in the 100 Hertz range. These materials and fluids science experiments are particularly sensitive to the frequency ranges SAMS will record.

The crew will activate the SAMS experiment halfway through Flight Day 1, then change out optical disks daily as they are filled. The experiment operates continuously for the duration of the mission.

Background: Prior to IML-2, the Space Acceleration Measurement System flew on nine Shuttle missions, including IML-1 in January 1992. In addition to the information SAMS provides for other experiments, NASA has used its data to better understand the microgravity environment in different areas of the Shuttle. The instrument is provided by NASA's Lewis Research Center in Cleveland, Ohio.

Quasi-Steady Acceleration Measurement (QSAM)

Payload Developer: German Aerospace Research Establishment (DLR)
Principal Investigator:
Dr. Hans Hamacher
DLR Institute for Space Simulation
Cologne, Germany

Objective: The Quasi-Steady Acceleration Measurement (QSAM) experiment is primarily designed to detect steady, very low-frequency, residual accelerations between 0 and 0.02 Hertz. These disturbances to the Spacelab microgravity environment include tidal accelerations caused by variations in Earth's gravitational field, atmospheric drag, and the slow rotation of the orbiter necessary to maintain its orientation toward the Earth.

Significance: This experiment, along with the Space Acceleration Measurement System, will provide the IML-2 mission with the most effective acceleration measurement systems.

Nearly all the IML-2 experiments rely on the state of microgravity -- commonly known as weightlessness -- to accomplish their goals. However, various disturbances exist in a spacecraft which make it impossible to achieve complete zero-gravity conditions. These include rapidly changing movements, like those of the crew or periodic equipment operations; and steady accelerations such as the slight pull on the Shuttle created by atmospheric drag.

All experiments can tolerate a certain level of disturbance. But different experiments are sensitive to different types of accelerations. Scientists need to know the exact level of accelerations that occur during their experiments to correctly interpret their results. In the past, the whole range of accelerations could not be covered by one system. QSAM will fill in the gaps by measuring steady, low-frequency accelerations, which affect some physical processes more than higher frequency accelerations.

Experiment Hardware and Operations: This experiment uses four rotating sensor heads and three stationary sensors to measure residual quasi-steady accelerations. The stationary sensors record accelerations of up to 50 Hertz. To achieve reliable measurements in lower frequencies, the accuracy of the sensors must be tested, or calibrated, in orbit. The rotating sensors measure accelerations in one axis, then flip 180 degrees and measure them in another, ensuring the accuracy of the readings. They should be able to sense disturbances as small as one ten-millionth of Earth's gravity (10^{-7}), ten times more still than theoretical "microgravity" (10^{-6}).

Measurements will be recorded throughout the mission on optical disks. The crew will activate the experiment about 12 hours after launch and change out disks approximately once every two days. Otherwise, the experiment operates autonomously.

Background: IML-2 is the first flight for this experiment, and one of the first which will take measurements of steady, very low frequency residual accelerations. The Quasi-Steady Acceleration Measurement system was developed by the German Aerospace Research Establishment (DLR).

Biostack (BSK)

Payload Developer: DLR
Principal Investigator:
Dr. Guenther Reitz
DLR Institute for Aerospace Medicine
Cologne, Germany

Objective: Biostack is part of a multinational program to determine the impact of high atomic number, high-energy cosmic radiation particles on life in space. It uses radiation detectors enclosed between a variety of biological specimens to monitor particles entering the Spacelab module. The specimens will be studied post flight to locate the path and entry point of each heavy ion in the biological layer, and determine the extent of any changes or damage it may have caused to the organism.

Significance: Orbiting spacecraft operate in a complex environment of electromagnetic radiation, charged particles from solar and galactic radiation, and charged particles created by the interaction of galactic radiation with Earth's atmosphere. Previous experiments indicate that particles of high atomic number and high energy have potentially serious side effects on living organisms. These effects cannot be fully investigated on Earth, because the atmosphere filters out most of this radiation. Biostack will help scientists understand the importance, effect and hazard of these high-energy particles on various living organisms in space. This is important to development of space radiation forecasting systems which may be needed for longer space flights.

Experiment Hardware and Operations: Three sealed aluminum Biostack containers are mounted in a Spacelab rack. Inside the containers, layers of different biological specimens are placed between different types of detectors to measure incoming radiation. When cosmic particles pass through the Biostack, they deposit their high energies in the layers of radiation detectors and specimens. This allows scientists to locate the trajectory of each heavy ion in the biological layer and to identify the site of penetration inside the biological subject.

The experiment uses two different strains of shrimp cggs and salad seeds. After the mission, scientists compare any damage to the specimens with cosmic particle penetrations identified by the detectors. This helps them assess how specific amounts of radiation affect different types of life.

The experiment, which is entirely passive, will collect particles throughout the mission.

Background: Biostack has a long history in the space program. Similar instruments flew in the 1970s on Apollo 16 and 17 and the Apollo-Soyuz Test Project. This experiment, developed by the German Aerospace Research Establishment (DLR), has flown previously on three Spacelab missions:

Spacelab 1 in 1983, Spacelab-D1 in 1985, and IML-1 in 1992. Results from the early missions demonstrated that high-energy particles can have serious biological effects on an organism, since complete cells can be damaged or destroyed. The ultimate consequences of such damage depend on the organism's ability to repair or replace the affected cell.

Extended Duration Orbiter Medical Project (EDOMP)

Payload Developer: NASA

Objective: The Extended Duration Orbiter Medical Project is designed to protect the health and safety of the crew during 12- to 17-day missions aboard the Space Shuttle. The series of investigations is designed to assess the medical status of the crew members and the environment in which they work.

Significance: As Space Shuttle missions become longer and as plans are made for extended stays aboard Space Station, it is essential to both understand the effects of weightlessness and radiation on space travelers and develop measures to protect them from harm.

Background: This medical project was developed by NASA's Johnson Space Center for missions where Extended Duration Orbiter equipment allows Shuttle flights to increase from the 7-to-10-day range to the 13-to 16-day flights.

The project is an umbrella designation for various activities designed to assess or protect crew health during long missions. Though elements of the project were included on earlier missions, it flew as a separate payload aboard the USML-1 Spacelab in 1992. IML-2 will be its second flight as a Spacelab payload.

For IML-2, the Extended Duration Orbiter Medical Project includes two experiments. The Lower Body Negative Pressure apparatus continues evaluation of a treatment to counteract orthostatic intolerance, the dizziness astronauts can experience as blood pools in their legs on return to gravity. The Microbial Air Sample tests air in the Spacelab and crew cabin for accumulations of airborne bacteria and fungi which may cause human illnesses.

Lower Body Negative Pressure

Experiment Group: EDOMP
Principal Investigator:
Dr. John Charles
NASA Johnson Space Center
Houston, Texas

Objective: The Lower Body Negative Pressure (LBNP) experiment evaluates the effectiveness of a treatment designed to counteract orthostatic intolerance, the "lightheadedness" astronauts sometimes experience when returning to Earth from space.

Significance: Without the force of gravity, astronauts' body fluids shift toward their heads and upper torsos. This shift is associated with other changes, such as fluid volume loss and altered control of cardiovascular functions. When space travelers return to Earth and "normal" gravity, body fluids are pulled back to the legs. Sometimes this creates a reduced blood flow to the brain when they stand up. In extreme cases, it could cause loss of consciousness. Treatments to counteract these effects protect the long-term health of the crew and ensure they will be alert for critical landing operations.

Background: LBNP was used on Skylab in 1973-4 to monitor loss of orthostatic tolerance in astronauts who spent up to 84 days in space. The current LBNP equipment first flew on STS-32 in 1990 as an independent payload. IML-2 will be its ninth flight.

Results from previous flights indicate that orthostatic intolerance can be countered by ingesting salt tablets and water while exposing the lower body to four hours of reduced pressure. This combined treatment has been shown to recondition the cardiovascular system for up to 24 hours. Spacelab-J tests on female astronauts indicated it is as effective on women as men, contrary to predictions based on bed-rest studies on the ground.

Operations: The primary equipment for the LBNP activity is a fabric bag in which a partial vacuum can be created. It encases the astronaut's lower body and seals at the waist. By slightly lowering the pressure within the bag, body fluids are drawn back to the lower extremities, mimicking the natural fluid distribution that occurs when a person stands up on Earth. This conditions the cardiovascular system to accept the ingested salt and water for reentry and improves orthostatic tolerance.

Two different procedures are conducted in the experiment. Four times during the flight, the LBNP device will be used to monitor the adaptation to space flight by Payload Specialist Chiaki Mukai and Payload Commander Rick Hieb. In these 45-minute "ramp" tests, the LBNP is gradually lowered and raised again. Measurements will be made of heart size and function by ultrasound cardiology, blood pressure and heart rate. Leg circumference will be measured before and after the sessions to determine the volume of blood in the lower body.

The day before landing, Hieb and Mukai will spend four hours with their lower body encased in the low-pressure bag. During the first hour of this "soak" treatment, they will drink water and take salt tablets. This combined treatment will pull fluids back into the lower body where they should remain for up to 24 hours. Scientists will evaluate the success of the treatment by examining cardiovascular data taken on Hieb and Mukai shortly after landing.

Microbial Air Sampler

Experiment Group: EDOMP
Principal Investigator:
Mr. Duane L. Pierson
NASA Johnson Space Center
Houston, Texas

Objective: The Microbial Air Sampler collects information on airborne contaminant levels in the Shuttle throughout the mission. Results from IML-2 will be added to data from previous flights to establish baseline microbial levels during missions of different lengths and to evaluate potential risks to crew health and safety.

Significance: Because certain microorganisms can cause allergic reactions or infections, maintaining acceptable air quality in "tight buildings" with little or no outdoor air is important to protect the health of people who inhabit those buildings. Spacecraft are the ultimate tight buildings, because the air supply is completely contained within the vehicle. In addition, particles that normally settle down onto the ground or other surfaces on Earth remain airborne in space.

Measurements of air quality taken before and after brief Shuttle missions suggest that inflight microbial levels are typical of those from crowded indoor environments. In the closed environment of the Shuttle, however, bacteria levels gradually increase during flight. This is not unexpected, since the Shuttle's air-handling system was not designed to remove airborne organisms.

If results show that levels of microorganisms increase during relatively long Shuttle missions to the point of becoming a concern, recommendations will be made to counter these effects with additional air-filtration devices.

Background: The Microbial Air Sampler first flew on the Spacelab Life Sciences-1 mission in 1991. IML-2 will be its eleventh flight.

Results from previous missions indicate that the low relative humidity in the Spacelab tends to reduce fungal propagation. Bacteria identified were those commonly associated with the human body, and the number tended to rise and then fall by the end of the mission. However, data collection on long-term missions is considered insufficient at this point to predict whether another rise in microbial particles may occur later in a long flight.

Operations: This experiment uses a hand-held, battery-powered air sampler. Air is pulled into the sampler by a motorized fan. Particles in the air are trapped within the device on plastic strips containing agar, a gelatinous material used to culture bacteria.

Crew members will insert an agar strip into the sampler, expose it to the surrounding air for two minutes to collect bacteria samples, then store the strip in a plastic bag for analysis back on Earth. They then will repeat the process with another strip, treated with a different solution to attract fungi microbes.

Astronauts will collect air samples from selected areas of the Spacelab, flight deck, or middeck near the beginning, middle and end of the flight. This procedure allows the number and type of airborne microorganisms to be identified over a relatively long Shuttle mission.

Slow Rotating Centrifuge Microscope Niedergeschwindigkeits-Zentrifugen-Mikroskop (NIZEMI)

Payload Developer: German Space Agency (DARA)

Objective: The Slow Rotating Centrifuge Microscope, NIZEMI, facility will provide scientists with the capability to observe both living and non-living matter exposed to levels of gravity ranging from 10^{-3} g (one thousandth of Earth's gravity) to 1.5 g. Free from Earth's gravitational pull, investigators will be able to see how organisms react to different gravity levels, and learn more about their gravity-sensing mechanisms.

Science: For IML-2, living matter such as slime mold, *Loxodes*, *Euglena*, jellyfish, *Chara*, cress roots and lymphocytes will be examined to determine how gravity affects cells and unicell and multicell organisms. Also, to investigate the solidification process of non-living matter at different gravity levels, scientists will observe a two-component mixture of succinonitrile-acetone, a transparent material which solidifies like metal.

Significance: Some plants and animals have specialized cells or organs that are responsible for perceiving gravity. Gravity-sensing mechanisms work, along with light and chemical substances, to keep the living organisms oriented. In order to provide an ecologically sound environment for extended stays in space, scientists must know more about the effects of microgravity on both living and non-living matter.

Experiment Hardware and Operations: The NIZEMI facility consists of three 19-inch (48 cm) modules. The NIZEMI Experiment Module contains a support module and the rotating centrifuge. The support module includes a halogen lamp to illuminate the samples as they react to the gravity variations, an electric motor drive for the centrifuge and special locking devices for the centrifuge during launch and landing. A front panel of the control unit displays the status of NIZEMI and the required crew activities. The centrifuge module contains two observation units, a microscope and a macroscope. The microscope has magnification powers of 32x, 20x, 10x, 5x and 2.5x. The macrounit has a field of view of 30 mm X 40 mm (about 1.2 by 1.6 inches) and a depth of focus of approximately 8 mm (0.3 inch). The samples, cameras and stages for moving and focusing the samples during the experiment are located in the centrifuge module.

The NIZEMI Control Module has a monitor, recorder, front panel and the electronics of the video system. The video system permits display and storage of video signals generated by the two cameras located on the centrifuge of the experiment module. These video signals will be merged with display data from the Experiment Control Unit.

During the mission, the control module will generate Spacelab closed-circuit television, record and display video signals, and select the camera signal (macro or micro) to be transferred to the monitor, recorder or Spacelab.

The experiment control unit has the display, keyboard, control electronics and power electronics. This module performs data acquisition for housekeeping and experiment data, controls the experiment flow and monitors the status of the NIZEMI facility.

Cuvettes are somewhat akin to slides used with a conventional microscope, and house samples from each of eight different experiment types. Once the sample is secured in the centrifuge module, the crew member will coordinate with the principal investigator on the ground to make sure the sample can be observed and recorded during the experiment run. Temperatures and centrifuge rotation are predetermined and controlled through the ECU.

Background: The NIZEMI facility will be used for the first time during IML-2.

Gravisensitivity and Geo(Gravi)taxis of the Slime Mold *Physarum polycephalum* (Slime Mold)

Experiment Facility: NIZEMI
Principal Investigator:
Dr. Ingrid Block
DLR Institute for Aerospace Medicine
Cologne, Germany

Objective: To add to the understanding of how a single-cell organism, the slime mold, senses gravity, and to attempt to locate the specific site at which this perception occurs.

Significance: When the slime mold (Physarum polycephalum) is on a vertical solid surface it moves downward when surrounded by air. On the same surface, this same slime mold would move upward when submerged in water. Scientists do not fully understand how or why the ectoplasm (elastic wall) of the slime mold accomplishes rhythmic contractions, although changes in response to light intensity and gravity have been documented on previous Space Shuttle flights.

Up to this point, investigators have not been able to pinpoint the specific site in the slime mold where it can sense and react to changes in gravity. By observing the behavior of the slime mold in the NIZEMI facility, scientists hope to be able to witness changes in the organism as it is subjected to different levels of gravity.

Operations: This experiment involves observing the single-cell organism, slime mold, as it is exposed to gravity ranging from 1.5-g to microgravity. After placing a videotape into the facility's video recording unit, the crew member will remove a selected slime mold cuvette from the incubator and place it in the NIZEMI centrifuge. Temperature and lighting are automatically controlled when the door is closed and locked by the crew member. Next, the crew member will focus on the sample slime mold and coordinate with the principal investigator on the ground. Once the scientist is satisfied with the location and quality of the sample view, NIZEMI will automatically process the sample.

Graviorientation in *Euglena gracilis* (Euglena)

Experiment Facility: NIZEMI
Principal Investigator:
Dr. Donat P. Häder
Friedrich-Alexander-University
Erlangen, Germany

Objective: This experiment is intended to determine the lowest level of gravity which can be sensed by a simple plant organism called Euglena gracilis. This free-moving single-cell flagellate orients itself in the water in relation to gravity and light, to reach the best habitat for photosynthesis and reproduction.

Scientists hope to learn how the plant's structure changes in microgravity. Some of the Euglena aboard Columbia are expected to reproduce, splitting into two organisms. The principal investigator's team wants to study if these organisms, which develop entirely in microgravity, react differently from the cells carried into space. Simple organisms are easier to study than complex, so scientists expect to gain insight into Euglena's threshold of sensitivity to gravity. For example, higher multi-cellular plant life perceives gravity with an organelle located in the root tip. The signal has to be transferred to a different part of the root, which then reacts to gravity's location. In this simple plant, all three of these activities -- perception, transduction and reaction, take place within one cell. Possible experiments for future missions would determine how the single plant cell transfers and reacts to this information.

Significance: Results based on studies of this unicellular "primitive" organism are ideal for interpreting and extrapolating the behavioral responses in more complex organisms and even humans. Furthermore, these organisms are ubiquitous and responsible for the production of oxygen. They also serve as sensitive evaluators for ultraviolet energy and toxic pollutants, such as heavy metals, which affect the orientation mechanisms of the cells.

Background: This is the first Shuttle flight for the experiment, but it has been preceded by extensive work on the ground. However, one theory suggests that perceiving levels of gravity is a passive process. It is believed that the back of the unicellular Euglena is heavier, similar to a buoy in water, causing the cell to always swim upward.

Other scientists believe that sensing gravity is an active process where a gravity receptor senses the direction of the Earth's gravitational field and signals the organism to swim in the opposite direction. First, Euglena was exposed to small amounts of ultraviolet radiation which impaired its ability to sense gravity. Scientists believe if Euglena used the passive, physical process to sense gravity, it would swim upwards even when exposed to radiation.

Operations: Team members believe they can determine the gravity-sensing mechanism by establishing the minimum gravity level the plant cell can detect and show a reaction to.

The microorganism will be exposed to various levels of simulated gravity in five-minute- increments in the NIZEMI slow rotating centrifuge microscope. A sample carried onboard the Shuttle in a 1-g centrifuge is scheduled to be placed in the NIZEMI early in the mission. This will be a control sample to determine Euglena's "normal" threshold of sensitivity to gravity. The run will start at 0-g, gradually increasing to 1.5-g in five-minute-increments for one hour. Mid-flight, one sample will be placed in the NIZEMI for an experiment run starting at 1.5-g and gradually decreasing over one hour to 0-g. Other experiment runs conducted at the middle and end of the mission will begin at 0-g, gradually advancing to 1.5-g.

These experiments should enable scientists to assess how Euglena adapts to microgravity. Video images will be analyzed with specially designed software, during the mission and after Columbia lands, to determine precisely when the micro-organism starts to perceive the simulated gravity and if the pull of gravity is being sensed by a gravity receptor. A microscope for observing single cells is mounted on the centrifuge plate of the NIZEMI apparatus.

Influence of Accelerations on the Spatial Orientation of the *Protozoan Loxodes Striatus* (Loxodes)

Experiment Facility: NIZEMI
Principal Investigator:
Dr. Ruth Hemmersbach-Krause
DLR Institute for Aerospace Medicine
Cologne, Germany

Objective: This experiment will study the orientation, velocities and swimming tracks of the unicellular organism, *Loxodes striatus*, to determine the threshold levels at which the organism begins to perceive gravitational forces.

Science: Previous experiments have demonstrated how some unicell organisms use gravity for their spatial orientation. One such organism, known as *Loxodes* *striatus*, has a specialized structure, the Müller organelle, which may be responsible for the perception of gravity. By exposing *Loxodes* cells to increasing accelerations in NIZEMI and observing changes in cell behavior, scientists can better determine the threshold of gravity perception in these organisms.

Significance: Since these cells may work similarly to the inner ear of vertebrates, this information is necessary for scientists to better understand the underlying mechanisms by which living creatures sense gravity.

Operations: The crew member will load a videotape into the NIZEMI video recording unit. Next, the crew member will select a sample of *Loxodes* cells from the passive thermal conditioning unit and place it into the facility's centrifuge. When the door to the centrifuge is closed and locked, temperature and lighting are automatically controlled. The crew member will then adjust the microscope to properly focus on the *Loxodes*, coordinating with scientists on the ground to ensure the best available view. NIZEMI automatic operations will then take over, exposing the *Loxodes* cells to increasing levels of acceleration, or artificial gravity, while a magnified view of the organisms' behavior is provided by the combination microscope/video camera system.

After landing, the *Loxodes* cells will be examined at high magnification by electron microscopy to determine changes in the structure of the gravity receptor and obtain information on the biomineralization of single cells.

Effects of Microgravity on Aurelia Ephyra Behavior and Development (Jellyfish)

Experiment Facility: NIZEMI
Principal Investigator:
Dr. Dorothy Spangenberg
Eastern Virginia Medical School
Norfolk, Virginia

Objective: This study of aurelia ephyra,a jellyfish, is intended to improve scientists' understanding of the effects of microgravity on the developmental processes of animals and the role that gravity plays in the developmental responses of organisms on Earth.

Science: Ten jellyfish will be used inflight during the IML-2 mission. Six Earth-developed ephyrae will be used to study behavior. Four ephyrae samples will be maintained in a microgravity environment and the other two will be maintained at 1-g, or simulated Earth gravity. Two jellyfish in microgravity will have no gravity-sensing organs (statoliths). These two will be exposed to different levels of gravity to determine their gravity threshold for normal behavior. Data will be obtained post-landing from inflight videotaping of some of the jellyfish experiments.

The remaining four jellyfish will be flown as polyps and be exposed to iodine during the flight, causing them to transform into ephyrae in space. Two of these jellyfish will be kept in microgravity and two will be centrifuged at 1-g in the NIZEMI. These jellyfish will be observed at regular intervals to compare the developmental stages of the ephyrae. Again, gravity thresholds will be determined by exposing the jellyfish to different levels of gravity and observing their behavior. The gravity receptors and muscles of the ephyrae that develop during flight will be examined after the mission to determine the presence and nature of any abnormalities.

Significance: This experiment will help scientists better understand the effects of microgravity on developmental processes of animals and the role of gravity in the behavioral and developmental responses of organisms on Earth.

Background: A related experiment flew on the Spacelab Life Sciences 1 mission in June 1991. Among other things, it confirmed that, even under microgravity conditions, jellyfish polyps undergo metamorphosis — transforming into the free-swimming ephyrae. However, the behavior of the ephyrae was modified in microgravity, whether the metamorphosis occurred in space or on Earth. During space flight, the ephyrae did not orient themselves as they do on Earth, where they sink mouth-downward when they stop pulsing. Rather, these ephyrae circled or looped while swimming and froze when they stopped pulsing.

Operations: After loading a videotape into the facility's video recording unit, the crew member will remove a cuvette containing a jellyfish from middeck stowage, place it in a cuvette holder and install it in the NIZEMI centrifuge. The crew member will coordinate with the principal investigator before the centrifuge door is closed and the experiment begins to run automatically, exposing the jellyfish to varying levels of microgravity. Some of the jellyfish will be preserved for post-flight analysis.

Gravireaction in *Chara* Rhizoids in Microgravity (Chara)

Experiment Facility: NIZEMI
Principal Investigator:
Dr. Andreas Sievers
Rheinische Friedrich-Wilhelms-University
Bonn, Germany

Objective: This investigation will use the viewing capability of the NIZEMI facility to determine the threshold values and minimal amount of gravitational force necessary for rhizoids of the simple plant, *Chara*, to react to gravity and change their direction of growth.

Science: Chara is a type of green algae that attaches to the base or material to which a plant is attached and from which it gets nutrients (substratum) by single cells called rhizoids. These rhizoids, tube-shaped, root-like organs that grow only at the tip of the cell, have membrane-enclosed barium sulfate crystals (statoliths) which cause the rhizoids to shift toward the force of gravity when the cell is turned or tilted. On Earth, it has been impossible to determine when the rhizoids first become sensitive to gravity. Knowledge of rhizoid growth and structural organization will be combined with video recordings of microscopic views of statoliths still attached to the rhizoids.

Significance: This investigation will help scientists understand how sensitive these single cells are to gravity and how they adjust to variations in gravity levels. This experiment, along with the study of cress roots, will add to scientists' understanding of gravity-sensing mechanisms, which have been studied intensively on Earth and in space.

Operation: Video microscopy will be used to observe the behavior of these statoliths in microgravity. The statoliths will be exposed to microgravity of varying strengths and durations. A sample of rhizoids will be labeled by the actin-binding drug phalloidin to allow investigators to observe the microfilament system where the statoliths are suspended. The crew member will put a videotape into the NIZEMI facility recorder before loading a *Chara* cuvette into the centrifuge. The crew member will coordinate all adjustments to the microscope with investigators on the ground. This experiment will run automatically.

Gravisensitivity of Cress Roots (Cress)

Experiment Facility: NIZEMI
Principal Investigator:
Dr. Dieter Volkmann
Rheinische Friedrich-Wilhelms-University
Bonn, Germany

Objective: This experiment will involve exposing chemically prepared samples of roots from cress plants to varying levels of gravity, to determine the lowest level at which the roots become sensitive to changes in gravity.

Significance: If we are to consider raising plants for food and oxygen in space, we must first understand how changes in gravity will affect plant growth.

Science: Seedlings of cress must sense gravity in order to survive. Previous experiments have shown that their roots are extremely sensitive to even short periods of exposure to gravity. After the samples have been subjected to gravitational stimulation in the NIZEMI centrifuge, they will be examined for indications of any resultant changes. Some of them will be preserved inflight for postflight examination with an electron microscope.

Future experiments with cress roots may reveal whether they can "remember" receiving tiny doses of gravity that may fall below their normal threshold doses.

Operation: A videotape will be placed in the NIZEMI centrifuge to capture the data from this experiment. Once this has been accomplished, the crew member will install a cress root cuvette and adjust the microscope to provide the best image possible during processing. This investigation is automatically controlled through the onboard experiment control unit.

Lymphocyte Movements and Interactions (Motion)

Experiment Facility: NIZEMI
Principal Investigator:
Dr. Augusto Cogoli
University of Sassari
Sassari, Italy
Space Biology Group of ETH
Zurich, Switzerland

Objective: This experiment is intended to determine whether or not T- and B-cells (immune system cells) can contact each other in a weightless environment.

Science: The activation of T-and B-cells is based on the exchange of messages, through soluble factors called lymphokines, as well as through cell-to-cell contact. In this experiment, colorless, weakly motile cells produced in lymphoid tissue (lymphocytes) will be observed to determine if they can make contact in space.

Significance: These cell interactions are critical for many biological functions, such as antigen recognition by immune cells. Observing these cells away from the influence of Earth's gravity will help scientists better understand the natural workings of the cells. An understanding of how the immune system works in microgravity will also be important during extended stays in space.

Operation: These cells will be activated with concavalir-A and incubated in the 37 degree Celsius (about 98.6 degree Fahrenheit) Biorack facility. The crew will remove a lymphocyte cuvette from the incubation rack and place the sample in the NIZEMI facility. Adjustments to the microscope will be made and the experiment started. The crew will be watching the cells' movements and contacts through the facility's microscope and views of the cells will be downlinked to scientists on the ground.

Background: This new Biorack experiment, which has not flown before, uses the NIZEMI facility for observation. A recent sounding rocket experiment provided direct evidence of cell contacts, with movements of cells in microgravity being detected by microscopic observations.

Convection Stability of a Planar Solidification Front (Moni)

Experiment Facility: NIZEMI
Principal Investigator:
Dr. Klaus Leónartz
Aachen Center for Solidification in Space (ACCESS e.V.)
Aachen, Germany

Objective: This experiment will use the NIZEMI facility to test a mathematical model for making predictive calculations of the onset of convection, a type of flow which is caused by localized density differences in a fluid, such as melted metal.

Science: Convection fluid flow changes the properties of the melt, as well as the resulting solid. The solidification process is influenced by gravity, the concentration of the mixture, temperature levels at which it is heated and cooled and the speed at which the liquid forms a solid.

Significance: Low-gravity experiments will help improve materials in the future as scientists begin to understand more about the solidification process. Many materials are produced from a melt. Commercially, the most important materials produced in this manner are metals, and the solidification process plays a key role in determining the resulting properties, such as strength and weight.

Operation: For this experiment, a two-component mixture of succinonitrile-acetone, which is transparent, will be used because it solidifies like metal. A crew member will place the cuvette containing the succinonitrile-acetone mixture into the NIZEMI facility. The transparent quality of this mixture allows the NIZEMI optical system to be used for observations of the solidification process as it occurs in low gravity.

Biorack

Payload Developer: European Space Agency

Objective: The effect of microgravity and cosmic radiation on isolated cells, tissues, bacteria, small animals and plants will be studied using the Biorack facility. A multi-user facility, Biorack was developed by the European Space Agency to permit scientists to conduct life sciences experiments in space.

For IML-2, Biorack will accommodate 19 experiments from seven European countries. While the hardware used in each study will be unique, all experiment specimens fit into containers stored within Biorack. About 200 experiment containers will carry chemicals and biological materials ranging from bacteria, mammalian and human cells, isolated tissues and eggs to sea urchin larvae, fruit flies and plant seedlings.

Significance: Since specimens may evolve through several stages of their lives (or in some cases, several generations) over the course of the mission, scientists can learn a great deal about the effects of microgravity and cosmic radiation on living tissues. Also, fundamental gravity-dependent processes on Earth can be studied in the microgravity environment where this force is reduced.

Background: The STS-65 flight will be the third Spacelab mission for ESA's multi-user facility. Biorack was used for the first time on the D-1 German Spacelab mission in 1985 and again on the first International Microgravity Laboratory mission in 1992.

Hardware: The Biorack configuration is smaller than for the previous missions. It is a single lab rack consisting of a glovebox, two incubators, two centrifuges, two stowage containers and a cooler. The thermo-electric cooler , which is connected to the Spacelab cooling water loop, was recently developed for the IML-2 mission.

The Biorack provides the crew with "laboratory" cabinets and work space. It contains modules which enable a wide range of biological experiments. Container racks and centrifuges are mounted on trays that slide in and out for easy access. Exposing duplicate samples to a simulated 1-g environment in the two centrifuges will help scientists differentiate between the influence of microgravity and other space conditions, such as radiation.

The glovebox of the Biorack is a class-100, particle-free, enclosed work area that provides safe conditions for the handling of materials. The glovebox keeps materials from floating across the Spacelab and keeps chemical fixatives confined. Crew members have the option of using gloves that extend into the sealed work area to handle specimens.

To enhance observation and documentation of samples, a still camera or a video camera can be mounted on the glovebox. The glovebox photo camera with a winder and a pneumatic shutter control can be installed to photograph objects inside.

Experiments are housed in sealed containers, a small Type I container, about the size of a deck of playing cards, and a larger Type II container, about three times the size of a Type I container. Each container can be fitted with a standard electrical connector to interface with power and data lines provided by Biorack. The incubators house 24 containers on static racks as well as 16 containers on two centrifuges that simulate Earth's gravity. The centrifuges can only hold Type I containers. They have a fixed speed of 107 rpm.

Five Shuttle middeck lockers are available for age-sensitive biological material and unstable chemicals. (Some of these lockers will be shared with the German NIZEMI facility.) To provide the necessary temperature environment during launch and landing, Passive Thermal Conditioning Units are used in the middeck area.

Operations: Biological specimens have to be transferred to Spacelab before being loaded onto the Biorack for experiment operations. The containers will be kept at +41 degrees Fahrenheit and +50 degrees Fahrenheit (+5 degrees and +10 degrees C). In-flight and during landing, NASA's Life Science Laboratory Equipment freezer provides -4 degrees Fahrenheit (-20 degrees Celsius) for containers carrying frozen specimens. In addition, flight samples are either cooled at 5 degrees Celsius or returned at ambient temperature for post flight analysis. Three hours after landing at Kennedy Space Center, the experiments stowed in the middeck during descent are returned to the principal investigators. Three hours later, frozen samples are returned for evaluation.

Antigen Presentation and T-Cell Proliferation in Micro-G (Antigen)

Experiment Facility: Biorack
Principal Investigator:
Dr. Augusto Cogoli
University of Sassari, Sassari, Italy
and Space Biology Group of ETH, Zurich, Switzerland

Objective: This experiment examines how white blood cells recognize and respond to foreign substances that enter the body. These foreign proteins, derived from pollen, virus or bacteria, are called antigens. Antibodies attached to the surface of the white blood cells recognize these foreign proteins and attach to them, provoking an antagonistic reaction.

Science: The human body has white blood cells, known as T-cells, on standby. Each particular type is responsible for recognizing, and finally fighting, millions of different "invaders". When called upon, the T-cells divide and proliferate. The antibodies, or surface receptor molecules, ride piggy-back on the T-cell. These antibodies recognize and adhere to the antigens much like puzzle pieces fitting exactly together. The antibodies can be released into the blood stream to fight the infection or, when the antigen is attached to a cell, the T-cells make cell-to-cell contact, invading the antigens to destroy or inactivate them chemically.

Significance: Infectious diseases have long been identified as the leading culprits behind human death worldwide. This experiment investigates basic processes that contribute to the understanding of diseases and how the immune system responds to external triggers such as germs and chemical factors (mitogens). It will specifically study the T-cell activation after exposure to antigens. Scientists want to know if the activation mechanism of lymphocytes by their specific antigens is also altered in space as is known to occur from studies using mitogen-activated cells. If both activation processes show similar changes, then a common gravity-dependent step must be affected by the space environment.

Operations: Cultures of mouse lymphocytes have been refined to specific T-cells. Some of these samples will be exposed to antigens, then incubated for 72 hours. Other samples will be incubated with a mitogen. The response of the lymphocytes is detected by marking cell products with a radioactive tracer. Scientists can observe the presence of this tracer in exceptionally small amounts of cell products.

Lymphocyte Activation, Differentiation, and Adhesion Dependence on Activation (Adhesion)

Experiment Facility: Biorack
Principal Investigator:
Dr. Augusto Cogoli
University of Sassari, Sassari, Italy
and Space Biology Group of ETH, Zurich, Switzerland

Objective: This experiment will seek deeper insight into the complex mechanism of white blood cell activation, which is essential for immune defense.

White blood cells, or lymphocytes, multiply to fight infections or to heal wounds. Before these cells can fight foreign substances within the body, they must be activated and proliferate. The substance that can stimulate cell division is called the mitogen.

Science: Lymphocytes can detect invading organisms or chemicals because they are equipped with surface receptor molecules (antibodies). The genes for those receptors can be shuffled and varied to produce structures that match virtually any foreign substance.

White blood cells free-floating in a liquid medium, called a suspension culture, will be used. On Earth, white blood cells are non-adhesive cells, meaning they do not attach to any surfaces. In this experiment, tiny plastic balls, resembling a fine powder, will be added to the suspension. They are called microcarrier beads. An interesting phenomenon which has been observed is that white blood cells adhere to the microcarrier beads. When they are growing on the microcarrier beads, the number of white blood cells activated more than doubles in microgravity. The inclusion of microcarrier beads increases the surface area available to the white blood cells to adhere to.

Significance: The power of the immune system to deal with infection is remarkable. However, the complexity of the immune response presents challenges to scientists and their attempts to decipher it. A deeper understanding of how the immune system responds to infectious agents is necessary.

An illustration of how this immune response works is that, on the cellular level, proteins situated on the cell membrane receive "passwords" from other cells flowing by. When a foreign cell or substance (antigen) is identified by these proteins, the white blood cells known as T-cells respond with production of specific substances (cytokines) which are controlled by the genes located inside the cell's nucleus. One step in this reaction chain seems to be gravity-dependent. Studying the process in orbit makes it possible to compare what happens in microgravity and under simulated 1-g conditions.

Background: A precursor experiment was Dr. Cogoli's investigation, "Lymphocyte Proliferation in Weightlessness," which flew on the Spacelab Life Sciences-1 mission in 1991.

Operations: Cells floating in a liquid called a suspension or attached to microcarrier beads will be incubated, activated with a mitogen, labeled with a tracer and preserved for postflight analysis.

Lymphocyte Movements and Interactions (Motion)

Experiment Facility: Biorack
Principal Investigator:
Dr. Augusto Cogoli
University of Sassari, Sassari, Italy,
and Space Biology Group of ETH, Zurich, Switzerland

Objective: Cell-to-cell contacts are one way in which white blood cells, such as T-cells and B-cells, exchange messages. This experiment will study the mechanics of this communication process by making direct observations of this phenomenon using the NIZEMI slow-rotating centrifuge and microscope.

Samples that have been chemically fixed in previous space flights indicate that cell-to-cell communication is taking place. Scientists wonder how the cells find each other in microgravity. They will directly observe if it is a random or active motion process.

Science: Postflight microscopic evaluations have shown that clusters of cells are formed, and that they communicate through the cellular membranes. Changing their shape allows the lymphocytes to move much like an amoeba and to find each other. Cell-to-cell contacts are important for the chemical exchange of information.

Significance: These cell interactions have a key role in many biological functions, such as immune cells recognizing disease-forming cells. Cell-to-cell contacts also are important for the exchange of chemicals which are a prerequisite for the human body's immune responses.

Background: A sounding rocket experiment has provided direct evidence of cell movements and contacts. The cell movements were detected by real-time microscopic observations.

Operations: Lymphocytes will be activated in the Biorack glovebox. They will then be incubated and transferred to the NIZEMI slow rotating centrifuge microscope. Crew members will observe the samples using that facility's specialized microscope at three different times during the mission.

Effect of Microgravity on Cellular Activation: The Role of Cytokines (Cytokines)

Experiment Facility: Biorack
Principal Investigator:
Dr. Didier Schmitt
Medical School Rangueil
Toulouse, France

Objective: The efficiency of activation of white blood cells, such as T-lymphocytes and monocytes, will be studied by measuring the production of substances that promote cell division. Cytokines, the production of which is inhibited in microgravity, are necessary to promote activation and proliferation of immune cells to fight disease. Investigators will measure the production of specific cytokines interleukin-1, interleukin-2 and gamma-interferon.

Science: Immune cells are those which help the body resist infection. Lymphocytes and monocytes, two types of immune cells, can be activated to produce cytokines, which in turn are necessary to activate other cells of the immune system. Monocytes can be activated by either adding synthetic growth-promoting factors such as phorbol esters or by increasing the intracellular calcium concentration. This is achieved by adding a specific calcium transport molecule to ease the calcium import to the cell. In contrast, T-cell lymphocytes need both of these methods simultaneously to be activated.

Significance: Previous space experiments have shown that the absence of gravity is interfering somewhere in this reaction chain. Scientists hope to determine which part of the reaction chain is altered in microgravity. They believe the information is being received by the cell, but the cell is not responding by dividing, as it normally would on Earth.

Operations: Cells are incubated in microgravity and on the 1-g centrifuge. About 15 hours after activation, cultures are filtered, the culture medium isolated, and cells are inactivated by a detergent. Postflight, scientists will compare the synthesis of different proteins in the cells and the culture medium will be examined for cytokines. If the medium contains these substances, scientists know that the nucleus was activated and responded properly by creating new cytokines. In addition, they will measure sugar consumption in the culture medium to determine the rate of cell growth and multiplication.

Effect of Microgravity on Cellular Activation: The Role of Cytokines (Phorbol)

Experiment Facility: Biorack
Principal Investigator:

Dr. Didier Schmitt
Medical School Rangueil
Toulouse, France

Objective: Immune cells can be activated to divide through the binding to a receptor of an artificial cell growth-promoting factor called phorbol ester. The phorbol ester crosses through the cell membrane to reach the receptor located within the cell. This receptor is an enzyme called protein kinase C (PKC). The phorbol ester attaches to the receptor much like two puzzle pieces fitting together.

If the ester does not bind to the proper protein receptor, cellular maturation slows down or the cells do not multiply. Investigators will use a radioactively marked phorbol ester to measure first if the ester joined to the PKC and, second, to see if the message was transmitted to the internal part of the cell.

Science: Previous experiments in microgravity have shown that microgravity dramatically reduces cells' maturation and proliferation. A related experiment on the Soviet satellite Biocosmos 2044 showed a decrease in the secretion of cytokines, that promote cell division of immune cells. Cytokines are proteins which serve as messengers between cells of the immune system.

Significance: Scientists believe the "activation" information is being received by the cell in microgravity, but the cell is not responding by dividing, as it normally would on Earth. Phorbol ester, a growth promoting factor, will be used to activate the lymphocytes. Scientists want to determine what is preventing the cell from multiplying. Then, they may be able to develop a synthetic drug to duplicate what is happening in the absence of gravity and be able to inhibit the free multiplication of cells, such as cancer cells.

Operations: For this study, lymphocytes will be incubated in microgravity and in simulated gravity on a Biorack centrifuge. During this time, the radioactively marked phorbol esters can bind to their receptors. Then, the binding is stopped and the cells are frozen. Postflight chemical analysis will reveal how effectively the phorbol esters bound to the intracellular receptor.

Cell Microenvironment and Membrane Signal Transduction in Microgravity (Signal)

Experiment Facility: Biorack
Principal Investigator:
Dr. Philippe Bouloc
CNRS Jacques Monod Institute
Paris, France

Objective: Previous space flight experiments have indicated that the membranes of animal cells may have altered permeability properties in microgravity. It also has been suggested that bacteria may be more sensitive to antibiotics in microgravity. This experiment is designed to test possible changes that take place in bacteria during space flight. Scientists will observe cell response to a natural stimulus (carbon dioxide gas) and an artificial one (sodium chloride). They will study the effect of the absence of fluid convection and gas exchange on cell growth.

Science: A non-infectious strain of *Escherichia coli* bacteria will be used. Thermal and gravity-driven fluid convection (fluid flows) are essentially absent in microgravity. Therefore, carbon dioxide gas produced during respiration is expected to remain concentrated in the direct environment of the bacterium, resulting in growth stimulation. This time frame will be measured.

How the cell responds to an artificial change in its environment -- the addition of a salt solution -- also will be observed. Using a "sensor" protein located in their outer membrane, cells can detect changes in the osmotic pressure of the fluid surrounding them. This is the pressure at which a dissolved substance attempts to make its way through a membrane, by means of osmosis. The bacteria respond in a number of ways, one of which is to produce an enzyme. Changes in the cell membrane would be likely to affect the transfer of information. Scientists anticipate that the bacteria will react to the salt solution in some way to retain its intracellular fluid.

Significance: If membrane alterations are detected in bacterial cells cultivated in microgravity, it will reinforce the interpretation of earlier findings using animal cells by indicating that the phenomenon is quite general, covering the entire range of life forms.

The investigation also will provide a convenient model system for studying the changes within the cell's membrane, which may involve the absence of convection in microgravity. An understanding of the phenomenon may, in turn, permit specialists to avoid possible undesirable effects of membrane alterations on astronauts.

Operations: The crew will inject glucose into bacteria suspensions, which should begin their growth and multiplication process. When the growth has started, some of the cultures will be injected with a salt solution to increase the osmotic pressure. Finally, an antibiotic will be injected to halt the growth process, but not kill the cells.

After Columbia lands, scientists will measure how much growth actually took place between the injection of glucose and the antibiotic injection. They also will observe if a particular enzyme was produced in response to the presence of the salt solution.

Effect of Stirring and Mixing in a Bioreactor Experiment in Microgravity (Bioreactor)

Experiment Facility: Biorack
Principal Investigator:
Dr. Augusto Cogoli
Space Biology Group of ETH
Zurich, Switzerland

Objective: This technology experiment studies the effect of stirring and mixing on the growth characteristics of baker's yeast in microgravity. The growth of baker's yeast is directly related to the consumption of nutrients, such as glucose and oxygen. Investigators will determine if stirring the solution increases the amount of growth that takes place because the cells are continually being redistributed.

Scientists also will measure the threshold where the yeast solutions change from normal growth into the production of alcohol, which is a critical part of the experiment.

Significance: This experiment may have broad implications for future life science experiments. The phenomena discussed here imply that a 1-g reference centrifuge aboard space laboratories is not necessarily an optimal control for all types of space experiments. Rather, stirring or mixing to achieve a homogenous reaction mixture of cells and solutes may be better suited. On a future mission, it will be desirable to study if there is any difference when this solution is stirred while in simulated gravity on a centrifuge. This would show if a centrifuge itself is a proper method to simulate gravity for reference experiments in space.

Science: On Earth, most cells in cultures sediment and form pellets if they are not mixed. Cells within these pellets on the bottom of the container quickly become depleted of oxygen and nutrients and are exposed to increasing levels of waste products.

Lack of sedimentation and convection in microgravity favors the formation of oxygen and nutrient gradients. An analogy would be the addition of chocolate to milk. On Earth, the chocolate sinks to the bottom. In microgravity, the chocolate and milk molecules hang side-by-side. Stirring the solutions might achieve a homogenous mixture, similar to mixing the chocolate syrup into the milk.

Operations: The yeast cells are contained in two special bioreactors; each fits into a Biorack Type II container and has a reactor chamber, a reservoir for nutrients and waste, mechanical components and electronics. Three milliliters (0.1 fluid ounce) of yeast culture is incubated in the reactor chamber. Fresh nutrient medium will be pumped at constant flow rates from the reservoir bag to the reaction chamber. The flow rate will be increased step by step to observe when the yeast switches from respiration to fermentation and begins forming alcohol.

Cells and medium will flow out through a one-way valve into the waste reservoir so that the volume of the culture remains constant. Experiment parameters of the chamber are controlled by a microprocessor, resulting in a stable environment. The bioreactor will run automatically for eight days, and data will be transmitted to the ground.

The crew will remove samples on specific days throughout the mission to determine if the yeast is expanding. The samples will be preserved for postflight analysis.

Molecular Biological Investigations of Animal Multi-Cell Aggregates Reconstituted under Microgravity (Aggregate)

Experiment Facility: Biorack
Principal Investigator:
Dr. Uwe Heinlein
Heinrich-Heine University
Dusseldorf, Germany

Objective: This experiment will evaluate whether organized tissues can be reassembled from single primary cells in microgravity. If the cells reassemble, or aggregate, to form organized, tissue-like cell layers, microgravity could be the key to learning how cells recognize one another and interact to form specific patterns.

Science: As organisms develop from embryos, the many tissues which form must recognize like cells and group to form the various parts of the organism. On Earth, the processes of cellular recognition are difficult to study outside the body in cell cultures. Gravity disturbs the cell surface interactions necessary for optimal pattern formation. Instead of attaching to each other, as they do when forming a tissue, the cells rapidly attach to the bottom of the culture flask. In microgravity, cells should not move toward the bottom of the flask but remain suspended and reaggregate to form organized tissue-like cell layers.

As gravity will not interfere with aggregation in space, the most likely influence will be molecular characteristics of the cell surfaces. Different cell samples are being flown with various types of adhesion molecules on their surfaces. Comparisons after the mission will help determine how cell surface structure influences aggregation.

Significance: Increased knowledge of how cells recognize one another to form tissues can be applied to overcoming problems related to tissue formation on Earth. For instance, some couples have difficulty conceiving children. One reason could be that the sperm does not recognize the egg, so fertilization cannot take place. If scientists can learn how cells communicate with one another, they might eventually be able to improve or prevent fertilization in humans.

Background: This experiment has not flown in space before.

Operations: This Biorack experiment will use primary cells prepared from two mouse tissues, brain cells from cerebellum and sperm-forming cells from testis. There are only five different kinds of cells in each tissue, making the tissues simple to study. Cells from the two kinds of tissues will be mixed before the experiment begins, to evaluate how well they can recognize like cells to aggregate into tissue over the course of the experiment.

Two containers with 10 cell cultures each will be placed in the Biorack incubator, one in microgravity and one in simulated gravity. A crew member will feed the cultures inside the glovebox on days two, four and six, by injecting a medium into the cell cultures. Growth will be chemically stopped, or fixed, on day six, and the containers will be stowed for the remainder of the mission. They will undergo postflight structural and chemical analysis.

Regulation of Cell Growth and Differentiation by Microgravity: Retinoic Acid-Induced Cell Differentiation (Mouse)

Experiment Facility: Biorack
Principal Investigator:
Dr. Siegfried de Laat
Netherlands Institute for Developmental Biology
Utrecht, The Netherlands

Objective: This experiment will study the effect of microgravity on mouse cell differentiation which has been induced by exposure to retinoic acid, a Vitamin A group acid. Cell differentiation is the process by which embryonic cells divide to form into the different types of cells which make up an organism.

Science: This experiment is one of several aboard IML-2 examining early cell differentiation and growth. The ability to "turn off the gravity" in space gives scientists a valuable tool for studying cell differentiation processes without introducing chemicals or other materials inside the cells themselves.

It has been known for a decade that the removal of gravity affects early cellular development, for instance that of the immune system's lymphocytes. Sounding rocket experiments have established that the change does not take place on the surface of the cells. Therefore, it must happen at some point farther along in the reaction chain of cell development. The various IML-2 cellular experiments are attempting to identify that point.

Mouse cells serve as a model for cellular behavior in other animals and in humans. Retinoic acid has a profound effect on their early differentiation, particularly on the pattern in which the limbs form. This experiment will investigate where the gravity-dependent step is located in the reaction chain of cell response to retinoic acid. It also will study how the mouse cells multiply after exposure to the retinoic acid in microgravity.

Significance: Identifying the stages in the reaction chain of early cellular development would provide a valuable tool for fighting a multitude of diseases.

Background: IML-2 is the first flight for this Biorack experiment

Operations: Sixteen containers housing two culture chambers each will be processed for this experiment. On the second day of the mission, a crew member will load them into the Biorack incubator, in the microgravity rack and the simulated-gravity centrifuge. There, they will be processed through a pre-programmed, automatic experiment sequence for seven days. Experiment controllers on the ground can verify that each event has occurred on schedule by viewing data transmitted from the Biorack facility.

After medium exchange, activation and fixation are complete, the crew will transfer 10 of the containers to the Biorack cooler and the rest to middeck stowage for return to Earth and subsequent analysis.

Sea Urchin Larva, a Potential Model for Studying Biomineralization and Demineralization Processes in Space (Urchin)

Experiment Facility: Biorack
Principal Investigator:
Dr. Hans-Jurg Marthy
CNRS Observatoire Océanologique
Banyuls-sur-Mer, France

Objective: This experiment studies sea urchin embryos and larvae to determine if the mineralization process that creates the typical sea urchin larva skeleton is normal in space.

Science: This is one of several experiments aboard IML-2 which researches the mechanisms involved in bone demineralization in weightlessness.

Previous tests of astronauts and small organisms have shown the lack of gravitational force on bone causes demineralization, the loss of calcium and other minerals. Although calcium loss may level off during space flight, the possibility that crew members could break weakened bones may affect their ability to function in Earth's gravity after an extended mission.

Significance: If this experiment finds there is a progressive loss of calcium and other minerals in the formed skeletons of sea urchins, that demineralization might be a good model for the loss of bone minerals experienced by humans in microgravity. Knowledge of the factors which govern bone demineralization could be applied to fighting disorders experienced by people on Earth such as osteoporosis, as well as helping protect space travelers.

Operations: A crew member will place containers with sea urchin eggs at two different stages of development in the Biorack incubator, in microgravity and in the gravity-simulating centrifuge. Several times during the mission, an astronaut will use the Biorack glovebox and a camcorder to make microscopic videotapes of swimming specimens.

Sea urchin larvae from all containers will be preserved at different stages of development. After the mission, scientists will analyze the preserved skeletons to assess their mineral composition and content.

Background: This Biorack experiment has not flown before.

The Effects of Microgravity and Varying 1-g Exposure Periods on Bone Resorption; an *In Vitro* Experiment (Bones)

Experiment Facility: Biorack
Principal Investigator:
Dr. J. Paul Veldhuijzen
Amsterdam Academic Center for Dentistry
Amsterdam, The Netherlands

Objective: This experiment will attempt to verify recent indications that exposing cultured fetal mouse bones to simulated gravity during space flight can prevent microgravity-related bone loss. Scientists want to see if exposure to a short period of gravitational force during each day in space would be sufficient to prevent adverse microgravity effects on the skeleton.

Science: Tests on astronauts and small organisms during previous space flights indicate that the lack of gravitational force on bones causes demineralization, the loss of calcium and other minerals. Scientists are still researching whether this calcium loss continues indefinitely or levels off during flight. If it continues, the likelihood that crew members will break those weakened bones increases the longer a mission lasts. Significant calcium loss also affects a person's ability to function in Earth's gravity after landing.

It has been shown that exposure of cultured fetal mouse bones to reduced gravity during space flight increased calcium loss. This suggests that cultured embryonic mouse long bones can serve as a model for studies on the cellular effects of microgravity on bone mineralization and demineralization in humans.

Different cells govern bone mineralization, the input of calcium into the bones, and demineralization, or calcium export. In childhood, the input is greater, stimulating bone growth. The two processes reach a state of equilibrium in adulthood. Export cells become more dominant as a person or animal grows old, causing bone deterioration, or osteoporosis. This experiment will attempt to identify how much of the calcium loss in microgravity is due to a repression of mineralization and how much is caused by an acceleration of demineralization.

Results of this experiment on IML-1 showed a significant increase in calcium loss in the microgravity samples as opposed to those in Biorack's simulated-gravity centrifuge, suggesting that exposure to artificial gravity counteracts bone deterioration. The IML-2 experiment will expose embryonic mouse long bones to varying durations of simulated gravity to determine how much exposure is needed to deter calcium loss.

Significance: Exercise which stresses astronauts' bones in space, much as the pull of gravity stresses them on Earth, has been shown to be effective in counteracting calcium loss. Information gained from this experiment could eventually be the basis for determining how much, or how little, exercise is necessary for it to be a useful countermeasure.

Bone demineralization is an integral part of the aging process. Insights into basic bone building and destruction processes are useful in fighting bone disorders on Earth such as osteoporosis, which affects a large percentage of elderly people.

Background: This experiment flew in Biorack on IML-1 and on the Russian Biocosmos satellite. The indications were that both bone mineralization and demineralization are influenced by microgravity.

Operations: Four cell culture containers containing fetal mouse long bones will be processed in the Biorack incubator in microgravity. One will be put into the simulated-gravity centrifuge, where it will remain for the duration of the experiment. Between the first and fourth flight days, three of the microgravity containers will be exposed daily to three, six and 12 hours of simulated gravity, respectively. Then all the samples will be chemically fixed to stop growth. Scientists will analyze the samples after the mission to determine how exposure to various levels of gravity affected bone growth and deterioration.

Investigation of the Mechanisms Involved in the Effects of Space Microgravity on *Drosophila* Development, Behavior and Aging (Drosophila)

Experiment Facility: Biorack
Principal Investigator:
Dr. Roberto Marco
Independent University of Madrid
Madrid, Spain

Objective: This experiment will study the development of fruit flies to test a theory about why the aging process of adult flies is accelerated in space.

Science: This experiment is one of several IML-2 investigations which attempts to determine if organisms can develop normally in space.

Previous experiments have shown that the exposure of young fruit flies to microgravity results in numerous effects on their development. These include an increase in the formation of eggs and an increase in the time required to complete the development process. However, the aging process of adult flies in these experiments has been accelerated.

During this long-duration flight, scientists will test an hypothesis that life shortening in space is linked to increased activity as the flies attempt to move in microgravity, along with excessive respiration. This ultimately results in damage to the part of the cell that provides energy to the cell by the respiration process.

Significance: Because the life span of flies is relatively short, almost their entire aging process can be studied during a Shuttle mission. Insights gained from this experiment could prove to be useful models in studying the factors which influence aging in humans.

Background: In a 1985 Spacelab D-1 experiment, investigators observed that the aging process was accelerated in flies exposed to microgravity. When this experiment flew on the Russian Biocosmos satellite, video of the flies' movement showed that their activity levels were greatly increased. An almost identical experiment flew on Biorack during IML-1 in 1992. However, the flies did not survive the flight. A small hole covered with a fine nylon mesh has been added to the fly containers to supply them with fresh air.

Operations: Fruit flies will be flown in space within the Biorack facility, both in microgravity and in the simulated gravity of the centrifuge. Activities of male flies will be recorded by video observations periodically throughout the mission. Embryos deposited by female flies will be frozen on specific days to preserve them for postflight analysis.

After the mission, the preserved embryos and live adult flies will be studied. Scientists will examine the flies' physical characteristics, biochemical makeup and behavior to determine the effects of microgravity on the genetic background, development processes, sexual behavior, orientation to gravity and aging.

The Role of Gravity in the Establishment of Embryonic Axes in Amphibian Embryo (Eggs)

Experiment Facility: Biorack
Principal Investigator:
Dr. Geertje Ubbels
The Netherlands Institute for Developmental Biology
The Hubrecht Laboratory
Utrecht, The Netherlands

Objective: This experiment examines the early stages of frog egg cell division, to determine the role gravity plays in directing cell division and differentiation as the cells form a new organism.

Science: Before space flight, organisms always developed with reference to gravity. Scientists are just beginning to study whether normal offspring will result when organisms mate and reproduce in space. This experiment will help them determine how organisms reproduce and develop without gravity. It also will give them greater insight into gravity's role in these processes.

On Earth, the eggs of clawed toads rotate shortly after they are fertilized, with a selected pole oriented downward toward gravity. Previous experiments suggest that gravity cooperates with the sperm in specifying the correct orientation, or axis.

The time and pattern of subsequent cell divisions are crucial in this early stage of embryonic pattern formation. At first, the cells divide almost in the same way at the same time. At later stages, this synchrony is progressively lost, making a "wave" of cell divisions over the egg. The cell population splits into compartments, each with its own division rhythm that corresponds to areas for later development of the organs, bones, etc. This experiment examines whether normal division synchrony in the early embryo is maintained under microgravity.

Significance: Insights into the early stages of cell development can serve as models for understanding the factors involved in normal development from a single cell to a complete organism.

Background: During a brief sounding rocket flight prior to the 1992 IML-1 mission, this experiment demonstrated for the first time that fertilization can take place in microgravity. Embryo development in space went on much longer during the IML-1 Shuttle flight. Postflight analysis of those embryos showed an irregularity in the thickness of cell layers at one stage of cell division.

A related experiment flew on Spacelab-J later in 1992, where eggs of live frogs were fertilized in space. The resulting embryos developed normally, indicating that any irregularity in cell formation due to microgravity was repaired during later stages of development. The IML-2 experiment will attempt to isolate the specific point at which the irregularity occurred.

Both IML-1 and Spacelab-J experiments indicate that gravity is not responsible for the orientation of the cell axis. This experiment will help confirm those results.

Operations: A crew member will place identical samples in Biorack's two incubators, with four samples in microgravity and two in the simulated gravity of a Biorack centrifuge. At the same time, identical samples will be incubated on the ground. Frog eggs will be fertilized within a microprocessor-controlled culture vessel. Samples from each test environment will be fixed to stop growth on the fourth and eighth cleavage, or cell division step, and in a later stage of embryonic development.

Postflight, samples from microgravity, simulated gravity in space, and Earth's gravity will be compared. The pattern of cell divisions, as well as the distribution of cellular constituents, will be determined in relation to axis formation.

Effect of Microgravity on Lentil Morphogenesis (Lentil)

Experiment Facility: Biorack
Principal Investigator:
Dr. Gérald Perbal
Pierre and Marie Curie University

Paris, France

Objective: The purpose of this experiment is to test a theory about how the gravity-sensing cells at the tip of plant roots regulate root growth.

Science: Gravity sensing cells called statocytes are found in a cap covering the plant root tip. The sub-cellular components are arranged within these cells with respect to gravity. The nucleus is always located in the top part, and membrane-enclosed crystals of barium sulfate, called statoliths, congregate on the bottom. When the root is placed in a horizontal position, the statoliths move toward the longitudinal wall but never touch the plasma membrane. It is generally accepted that the statoliths are responsible for sensing gravity, but the way they do that is still controversial. This experiment tests the hypothesis that the settling down of the statoliths on the endoplasmic reticulum, a web-like structure within the cell protoplasm, regulates root growth.

Significance: Scientists are still investigating which direction plant roots will grow when there is no distinguishable up or down, as is the case in the weightless environment of space. Researchers also want to know if root growth is inhibited by changes in growth direction. These questions must be answered before plants can be grown as part of a controlled ecological environment needed for long-term stays in space.

Equipment and Operations: In this IML-2 experiment, six different groups of lentil seeds will be exposed to both microgravity (after germination on the 1-g centrifuge) and 1-g environments. The seeds will be hydrated with water or cytochalasin B in the Biorack glovebox on day 10 of the mission and transferred to the 22 degree Celsius (72 degrees Fahrenheit) incubator. After one day of growth, the seedlings will be photographed with the glovebox camera. The principal investigator on the ground will observe the seedlings via television and will talk with the crew to confirm the correct growth status. The seedlings from the centrifuge will be returned to incubate in the static rack and those in the static rack will be placed on the centrifuge. The seedlings will be photographed again two hours later (also with video downlink) and fixed (preserved with glutaraldehyde) for analysis after the mission.

Background: This experiment is nearly identical to the "Roots" experiment flown on IML-1. It uses the same hardware, biological samples and chemicals, with the addition of mini-syringes containing cytochalasin B for IML-2. Results from the IML-1 Roots investigation show that plant roots were sensitive to periods of alternating gravity and microgravity. However, scientists do not fully understand how changes in the growth direction of these roots will affect overall growth.

Root Orientation, Growth Regulation, Adaptation, and Agravitropic Behavior of Genetically Transformed Roots (Transform)

Experiment Facility: Biorack

Principal Investigator:
Dr. Tor-Henning Iversen
University of Trondheim
Dragvoll, Norway

Objective: This experiment will test whether the growth of plants that grow in any direction apparently unaffected by gravity (agravitropic roots) on Earth is similar to normal roots grown in microgravity.

Science: Three clones of transformed, agravitropic roots have been isolated. Normal gravitropic roots, which grow downward, will be used as the control subject specimens for this experiment. In addition, single transformed cells which have been isolated from these roots will be tested. These cells will be isolated as protoplasts (cells from which the cell walls have been removed). After the mission, scientists will attempt to regenerate intact plants from the protoplasts.

Significance: Transformation of plant cells by strains of a bacteria known as *Agrobacterium* causes dramatic changes in the metabolism of the transformed cells and the physical characteristics of the intact plants regenerated from the transformed cells. Wild type strains of *Agrobacterium rhizomes* are known to induce transformed roots called "hairy roots." These roots have a high growth rate, branch out excessively and, in some cases, do not exhibit curvature in response to gravity (gravitropism). Scientists must learn more about plant growth in microgravity before plants can be included as part of the ecological environment system for longer stays in space.

Experiment Hardware and Operation: The plant chambers for this experiment are made of aluminum frames with clear windows to allow for photography. The protoplast cultures will be in plastic bags, heat-sealed at one end, with a sterile seal (septum) at the other end.

During IML-2, containers with root segments will be incubated at 22 degrees Celsius (72 degrees Fahrenheit). At selected times, the plant chambers will be exposed to 1-g, placed in the photobox for automatic photography, fixed (preserved with glutaraldehyde) in the glovebox, and stored in the Biorack cooler. The protoplast cultures will undergo incubation (in both microgravity and 1-g), fixation, washing with a buffer and cooling.

Background: This is a new Biorack investigation that has not flown before. However, the hardware is similar to the Roots and Proto experiments flown on IML-1. The photobox is identical to that flown on IML-1, but the sample holder has been modified to accommodate experiments for IML-2.

Plant Growth and Random Walk (Random)

Experiment Facility: Biorack
Principal Investigator:

Dr. Anders Johnsson
University of Trondheim
Dragvoll, Norway

Objective: This experiment will observe root behavior in a weightless environment, with the aim of increasing our knowledge of root growth dynamics.

Science: Experiments on Earth have shown that plants exposed to gravity levels higher than 1-g grow in a more "straight" fashion. Changes in the normal growth patterns are caused by spontaneous random movements and the nature of these movements can only be studied in an environment free from Earth's gravitational pull.

Scientists have hypothesized that the random movements can be described and treated as a "random walk" process (similar to the random motions of molecules in a liquid). This hypothesis will be tested in the weightless environment of space during IML-2. Although photographs will provide the main source of information from this experiment, samples will be fixed (preserved with glutaraldehyde) and returned to Earth for analysis.

Significance: A quantitative study of root behavior in space will test the random walk hypothesis and increase our knowledge of the dynamics of root growth. Research such as this will help reveal the role of gravity in shaping life as we know it and show us how living organisms react and adapt to microgravity.

Operations: *Lepidium sp.* seedlings, which are housed in plant chambers with clear windows, will be transferred to a photobox at about 11 and 17 hours into the mission. Time-lapse photography will be performed over a 35-hour period. Other containers of seedlings will be exposed to 1-g on the centrifuge inside the 22 degrees Celsius (72 degrees Fahrenheit) incubator for 18 and 20 hours and will then be transferred to the photobox to provide visual documentation of their growth patterns.

Background: This is a new Biorack experiment that has not been flown before. It is, however, similar to the "Roots" experiment flown on IML-1. The photobox is identical to the one flown on IML-1, but the sample holder has been modified to accommodate this experiment and the mirrors have been removed.

Dosimetric Mapping Inside Biorack on IML-2 (Dosimetry)

Experiment Facility: Biorack
Principal Investigator:
Dr. Guenther Reitz
DLR Institute for Aerospace Medicine
Cologne, Germany

Objective: This investigation is designed to provide a baseline of radiation data for all Biorack scientists to use when analyzing their respective experiment results.

Science: This information is a precondition for any investigation in space that might be susceptible to radiation. In order to provide scientists with a good baseline of radiation information, this experiment will document the radiation environment inside the Biorack facility and compare the data with theoretical predictions and data from previous flight experiments.

Significance: From the data collected during this experiment, principal investigators will be able to distinguish microgravity effects from radiation effects on samples that were placed in the Biorack facility. Although the Spacelab module has special radiation shielding, cosmic radiation does penetrate the spacecraft. Previous investigations have shown that radiation can be particularly damaging to single cells. Scientists must be able to predict and measure the influence of cosmic radiation when determining flight parameters and the amount of shielding needed to conduct experiments in space.

Equipment and Operations: Each of the seven dosimeters contains three types of visual track detectors with various layers of cellulose nitrate, Delrin, Kapton foil and nuclear emulsion. Before launch, dosimeters will be placed in the 22-degree Celsius (72 degrees Fahrenheit) and 37-degree Celsius (99 degrees Fahrenheit) incubators; one will be loaded into the Biorack cooler, one into the Biorack stowage, one to overhead stowage, and the remaining two will be kept in ambient stowage.

Background: This experiment is identical to the investigation of the same name that flew on IML-1. For IML-2, all experiment hardware has been newly fabricated. Results from IML-1 showed that radiation in the two Biorack incubators was similar. By placing additional dosimeters in other areas of the Biorack facility, scientists will be able to see if radiation levels are different throughout the facility.

Efficiency of Radiation Repair in Prokaryotes (Repair)

Experiment Facility: Biorack
Principal Investigator:

Dr. Gerda Horneck
DLR Institute for Aerospace Medicine
Cologne, Germany

Objective: This experiment will test the hypothesis that gravity affects the ability of biological systems to repair and recover from radiation damage. Scientists will observe radiation-damaged *Bacillus subtilis* bacteria to see if they form microcolonies to begin their repair process.

Science: Scientists for this experiment have selected a variety of bacteria cultures that are genetically well-defined, each having a different capacity to repair damage to its deoxyribonucleic acid (DNA). The first step in the repair process is for cell proteins to recognize damaged sites in the DNA. This involves the initial random collision of molecules and may be affected by gravity.

Significance: Scientists will use data from this experiment to understand more about the ability of biological systems to repair themselves after radiation damage in space. Before humans can stay in space on longer Space Shuttle flights or live and work for extended periods of time aboard the space station, we must know more about the role that microgravity plays in the ability of cells to repair themselves after being exposed to radiation on orbit.

Operations: Three containers with X-ray irradiated bacteria spores and a pipette with a culture medium syringe are launched in Spacelab. During the last days of IML-2, bacteria cultures will be activated and placed into the Biorack 99 degrees Fahrenheit (37-degree Celsius) incubator. After about 20 hours of incubation, photographs will be taken of the microcolonies using the Biorack glovebox camera. Scientists on the ground will watch downlink television to determine when the cells should be preserved. The kinetics and efficiency of these bacteria cells in repairing DNA will be analyzed after the mission.

Background: This is a new investigation that has not flown before.

Radiation Repair Kinetics in Eukaryotes (Kinetics)

Experiment Facility: Biorack
Principal Investigator:

Dr. Gerda Horneck
DLR Institute for Aerospace Medicine
Cologne, Germany

Objective: This experiment will examine the ability of radiation-damaged cells to repair themselves in microgravity.

Science: Scientists will use human skin fibroblast and bacterial cells, *Escherichia coli* and *Deinococcus radiodurans*, to understand more about how cells repair themselves in space. Although scientists are aware that microgravity and radiation exposure affect living organisms, the ability of cells to repair and recover has not been explored in microgravity.

Significance: The Spacelab module has special radiation shielding, but some cosmic radiation does penetrate the spacecraft. Previous investigations indicate that radiation can be particularly damaging to single cells and that cells exposed to both microgravity and radiation may suffer more damage than cells exposed to only one of these effects. Before humans can stay in space for extended periods of time, we must first understand how cells repair themselves when they have been exposed to microgravity and radiation.

Operation: For this experiment, the cells will be exposed to ionizing radiation before the mission to damage their deoxyribonucleic acid (DNA), causing effects such as strand breakage in the double helix. The cells will be frozen until this experiment begins to prevent them from starting the healing process before they are exposed to microgravity on orbit. A commercial thermos has been modified to keep samples frozen during launch. Immediately after Spacelab activation, the vessels containing the cell samples will be transferred to the refrigerator/freezer where they will remain until they are activated during the mission. After activation, the cell samples will be incubated at 37 degrees Celsius (99 degrees Fahrenheit) for defined periods of time to allow the cells' enzyme systems to repair the damage from the ionizing radiation. After the various incubation periods, these samples will be returned to the refrigerator/freezer for their flight back to Earth. Freezing the cells in different stages of repair will allow scientists to see how much radiation damage was left unrepaired in microgravity. After the mission, investigators will examine the DNA and compare the cells that repaired themselves in microgravity with samples that repaired themselves on Earth.

Background: This is a new Biorack experiment that has not been flown before.

Real-Time Radiation Monitoring Device (RRMD)

Payload Developer: NASDA
Principal Investigator:
Dr. Tadayoshi Doke
Waseda University
Tokyo, Japan

Objective: This device will actively measure the high-energy cosmic radiation which enters the Spacelab in orbit, then transmit those measurements to the science team at the Payload Operations Control Center in Huntsville. The signals also will be transmitted to remote centers where they will be compared with other current radiation information, such as optical and X-ray observations.

In addition to real-time radiation monitoring, the device will contain bacteria with high radiation sensitivity. Scientists will analyze the bacteria cells post flight to measure radiation damage and study their ability to recover and repair themselves after a cosmic-ray impact.

Significance: This IML-2 device is the first to transmit radiation information to the ground during a mission. It serves as the beginning toward creation of a space weather-forecasting network which might be established for future spacecraft.

Space is a complex environment filled with electromagnetic radiation and charged particles. Previous experiments have shown that particles of high-energy radiation have potentially serious biological effects on living organisms. Earth's atmosphere shields people on the ground from most of these effects, but space travelers do not have the atmosphere to protect them. On longer spaceflights, radiation storms due to increased levels of solar activity could be hazardous to astronauts. A reliable space radiation forecasting system could warn them to take shelter in a protected area of their spacecraft until the danger has passed.

Experiment Hardware and Operations: The Real-time Radiation Monitoring Device consists of a detector unit, a control unit, and passive track dosimeters. The detector rapidly collects data necessary to analyze the influences of radiation on the crew, the payload and biological specimens. During the flight, each time a cosmic ray particle enters the Spacelab, a spectroscope sensor measures the energy and direction of the particle. The electronic control unit records signals from the detector and transmits them to the ground. Also, the radiation-sensitive bacteria are sandwiched between solid-state nuclear track detectors in a container on top of the spectrometer.

The crew will mount the monitoring device in the Spacelab aft end cone shortly after launch. It will collect data throughout the mission. Crew members will change the direction the device faces about once every three days.

After the mission, records of real-time radiation readings will be compared to information from the passive radiation trackers, attached with biological specimens on top of the active detectors. They also will be compared with Biostack detector data from this and previous missions.

Background: IML-2 is the first flight of this experiment. It was developed by the National Space Development Agency of Japan as an addition to their life science hardware from Spacelab-J.

Microgravity Effects on Standardized Cognitive Performance Measures

Principal Investigator:
Dr. Samuel G. Schiflett
U. S. Air Force Armstrong Laboratory
San Antonio, Texas

Objective: This experiment will help determine astronauts' mental ability to perform operational tasks in space. Scientists want to measure how well the crew processes information so they can distinguish between the effects of microgravity and fatigue.

Six computerized cognitive performance tests called the Performance Assessment Workstation (PAWS) will be used during the flight. After Columbia lands, Air Force personnel, standing in for the STS-65 crew, will re-enact all mission procedures. The scientists will compare the results of the two groups in an effort to precisely pinpoint the effects of microgravity.

Significance: As technology takes us physically and mentally farther away from the evolutionary environment of Earth, humans will be exposed to a variety of conditions that may cause their performance to deteriorate. The Performance Assessment Workstation provides scientists with a tool to assess cognitive performance and, thus, measure the impact of new and unknown stress factors.

While measurement of performance is only the first step toward understanding the effects of spaceflight on cognitive functioning, it also allows space scientists to quantify any problem so that specific solutions can be developed to counteract any loss of productivity.

The results will provide information to help planners more effectively schedule astronauts' work under a variety of conditions, such as fatigue. This should lead to improved productivity during space missions through, for example, scheduling tasks at times when crew members' performance is optimum.

Science: Present day space travelers are subject to a variety of stresses during space flight. These include the microgravity environment, physical isolation, confinement, lack of privacy, fatigue and changing work-rest cycles. On Earth, both fatigue and changing work-rest cycles are known to degrade cognitive performance and productivity.

Hardware: The crew will undergo performance tests using a laptop computer. The Performance Assessment Workstation tests are based on current theoretical models of human performance. They were selected by analyzing tasks involved in space missions that might be sensitive to microgravity. Subjective questions also are included in PAWS for interpreting fatigue and mood states.

The investigation uses a set of six computerized cognitive performance tests taken from the Unified Tri-Service Cognitive Performance Assessment Battery. The series of tests is internationally recognized and has proven sensitive to many environmental stressors.

Operations: While in orbit, crew members will take the tests daily. The computer will record the speed and accuracy of the astronaut's responses to rotated images, letter sequences, math calculations, spatial patterns and recollection of numbers. It also records the astronaut's ability to track an unstable object on the computer screen using a precision trackball.

Perhaps the most challenging test for the astronaut will be to do two things at one time and rapidly switch attention between the two tasks. The computer screen will be divided in half to feature two test questions. Each screen will be answered in a sequential manner determined by an indicator at the bottom of the screen. For example, the left screen might illustrate a spatial ability test while the right screen features an addition test.

Performance criteria for comparison will be collected during practice sessions held during the weeks before launch for the crew member subjects. Also, scientists will continue to gather data after the astronauts return to Earth. The postflight data will be collected to determine the rate of recovery of any detrimental effects of microgravity on cognitive information processing.

Spinal Changes in Microgravity

Payload Developer: Canadian Space Agency

Principal Investigator:

Dr. John R. Ledsome
Canadian Space Agency
Ottawa, Ontario, Canada

Objective: Two out of every three people who go into space experience back pain that scientists believe may be related to a lengthening of the spinal column in microgravity.

The objective of this IML-2 experiment is to determine whether the lengthening of the spinal column can be associated with changes in the function of the spinal cord or spinal nerve roots which branch off the spinal cord. It will investigate the effects of nerves that are stretched close to their limits by the lengthened spinal column, as well as the changes in body function controlled by the central nervous system.

In addition, the study will determine for the first time if the lengthening of the spinal column causes changes in the cardiovascular and bladder functions.

Science: The back does more than allow us to stand up straight. It houses the spinal cord and nerves that connect the spinal cord to the other parts of the body. It's likely that when the nerves are stretched they will not work properly. This experiment will study two types of these nerves: sensory nerves that carry signals from the skin to the brain and autonomic nerves that are responsible for involuntary bodily functions such as blood flow.

To determine the function of the sensory nerves, the ability of the spinal cord to conduct an electrical impulse from the foot to the brain will be measured. Normally when we breathe in, our heart rate decreases. When the breath is released, the heart rate increases. If there is a change in the interaction between breathing and heart rate, it might be due to changes to the autonomic nerves going to the heart.

The spacing between discs in the vertebrae will be measured to determine if that is the reason for the height increase, or if it is due to the straightening of the back's curvature.

Significance: This experiment will provide an insight into the function of the major nerves of the spinal cord during space flight and help understand the back pain reported by astronauts. The information has already proved valuable in understanding and assessing chronic back pain on Earth. Some of the techniques have been applied to back surgery performed in Canada.

Background: On IML-1, the first systematic measurements of changes in height and spinal contour were performed. Results indicated that the astronauts increased in height from two to three inches. There also was flattening of the normal spinal contour. Scientists believe this may be the cause of the back pain that many astronauts experience during space flight.

Operations: The STS-65 crew will complete a daily questionnaire describing any back pain and associated symptoms of spinal cord dysfunction, such as numbness. Crew members also will measure their height daily.

Three times during the flight -- at the beginning, middle and end -- they will take stereophotographs in seven different positions designed to provide information about changes in spinal contour, height and the range of motion of the vertebral column. They also will be conducted pre- and post flight, along with magnetic resonance imaging of the spine and clinical back examination.

To study sensory nerves, crew members will stimulate their nerves with a tiny electric impulse at the ankle and time how long it takes the signal to reach the brain using a nerve stimulation and recording device. On Earth, it usually takes about 50-thousandths of a second, whereas in space the transit time is unknown.

To study autonomic nerves, crew members will squeeze a hand grip measuring device for several minutes -- a form of isometric exercise. At the same time, blood pressure and heart rate are measured to determine the adaptation of the heart to muscular work. A second study will measure heart rate as the astronaut synchronizes breathing to cues on an audiotape. Changes in the breathing/heart rate relationships are sensitive indicators of cardiac changes.

Thermoelectric Incubator (TEI) and Cell Culture Kits (CCK)

Payload Developer: NASDA

Objective: The Thermoelectric Incubator is a general-purpose incubator used in the Spacelab module to maintain biological specimens at a constant temperature, humidity and carbon-dioxide concentration. It provides a growth environment for both animal and plant cells.

The Cell Culture Kits will be used to culture slime mold and plant and animal cells in microgravity. The kits allow observation of cell growth, the extraction of materials produced by these cells, and the fixation of the cells for inspection after return to Earth.

The incubator and cell culture kits also will be used in conjunction with some of the Free Flow Electrophoresis Unit experiments.

Significance: This equipment allows scientists in the microgravity environment of Spacelab to study cell development and growth in much the same way as they would in their labs on Earth. Results will provide insight into how microgravity and radiation affect the development of cells in space. Comparison with ground-based experiments will help scientists understand how gravity shapes life on Earth.

Experiment Hardware and Operations: Cell-culture kits are pre-assembled packages of various items the scientist in orbit needs to perform culture experiments. They allow astronauts to take maximum advantage of the time available, as the kits make available in a single location all the equipment needed for a particular experiment.

Each kit includes a main chamber, containers for culture mediums, waste collectors, applicators, syringes and containment bags. For IML-2, three different types of kits will support animal cell-culture and electrophoresis experiments. Petri-dish-type chambers will be used for the slime mold and plant cells. Animal cell culture kits have transparent windows which allow crew members to observe cell cultures grown in orbit with a Biological Microscope. They will use a 35-mm camera, which attaches to the microscopes, to make still photographs of the samples.

For the slime mold culture, a video system will record and downlink real-time images of specimens to scientists at Spacelab Mission Operations Control in Huntsville.

The Thermoelectric Incubator will operate at around 98.6 degrees Fahrenheit (37 degrees C). Experiment samples within the incubator are secured by a bungee cord to prevent damage from vibration and keep them from floating away when the door is opened.

Background: This equipment is provided by the National Space Development Agency of Japan. Along with the Free Flow Electrophoresis Unit and the Aquatic Animal Experiment Unit, it was part of the First Material Processing Test – Life Sciences, which flew aboard the Spacelab-J mission in 1992.

Gravity and the Stability of the Differentiated State of Plant Embryos

Experiment Facility: Cell Culture Kits
Principal Investigator:
Dr. Abraham Krikorian
State University of New York at Stony Brook
Stony Brook, New York

Objective: This experiment aims at determining the role gravity plays in the earliest stages of plant development. It will grow daylily and carrot cells in two different culture environments to validate the outcome of its predecessor experiment on Spacelab-J. On that mission, a large number of plant cells developed with two nuclei. Cell division was taking place, but the walls which should have separated the two cells did not form.

Significance: This experiment will help determine if cell development can begin in the absence of gravity. It tests and profiles critical stages in plant cell development, called embryogenesis, and examines the effect of microgravity on cell division and chromosome behavior. The experiment also tests for other space environment effects such as radiation.

Results will provide fundamental biology information about the workings of a cell on Earth. Potential long-term benefits could range from manufacture of artificial seeds to the storage of vast, varied food supplies in a very small space (the size of a culture dish). This knowledge is critical for implementing space-based plant biotechnologies to feed future space travelers on long planetary flights.

Operations: Carrot and daylily cells will be grown in six plant cell chambers and six plant fixation chambers, so that two basic types of cell culture environments can be evaluated.

Astronauts will place a radiation detector with the plant cell chambers and store them in a Spacelab rack compartment when the experiment begins. Cells with the ability to develop into embryos will be launched in a culture medium which keeps them inactive. Within a few days, the cells will be automatically developed themself. These samples will be stored in the rack as well. Late in the flight, the crew will add a chemical to some of the cells to stop their growth and preserve their characteristics.

Comparison of the preserved samples with those returned to Earth alive will ensure that any abnormalities seen in the cells are not due to the stress of landing. Some of the space flight embryos will be incubated after the flight and examined on an ongoing basis for any temporary or longer-term effects of their genesis in the absence of gravity.

Background: On Dr. Krikorian's Spacelab-J experiment, both the degree and rate of development of plant cell generation were altered. There were significant abnormalities in the status and behavior of the nucleus of cells making up the embryo, with fracturing and changes in chromosome structure.

Effects of Microgravity on the Growth and Differentiation of Cultured Bone-Derived Cells

Experiment Facility: TEI
Principal Investigator:
Dr. Yasuhiro Kumei
Tokyo Medical and Dental University
Tokyo, Japan

Objective: This experiment compares functional differences in bone cell cultured in Earth's gravity compared to cells cultured in microgravity and determines the genes responsible for any differences. The ultimate goal is to clarify the causes for the bone atrophy, or osteoporosis, induced by space flight.

Significance: Previous Shuttle experiments have shown that animals lose calcium during space flight. Ninety percent of the calcium is found in the bone. Bone loss could pose more serious hazards for space travelers on long-duration missions. It's hypothesized that genes governing bone production are either stimulated or suppressed during space flight.

In addition to benefiting the health of future space crews, an increased understanding of the mechanism of osteoporosis eventually could help prevent bone disease on Earth and improve therapy for immobilized patients who experience similar bone atrophy.

Operations: Four culture chambers filled with bone cells from the back legs of young adult rodents will be studied in this experiment. Those cells are particularly sensitive to the sudden absence of gravity's pull on the skeleton in space. Astronauts will make microscopic and photographic observations of cell growth through transparent windows in the animal cell culture containers.

The cultures will grow in the Thermoelectric Incubator at 98.6 degrees Fahrenheit (37 degrees C), beginning just a few hours after launch. Three days later, crew members will remove two culture chambers from the incubator. They will extract cell samples from both chambers and refrigerate them. Other samples from those two containers will be frozen. The two remaining cell culture containers will continue to incubate until Flight Day 9, when the collection procedure will be repeated.

After the mission, the samples will be examined for the differences in bone cell production during exposure to microgravity.

Differentiation of *Dictyostelium discoideum* in Space

Experiment Facility: Cell Culture Kits
Principal Investigator:
Dr. Takeo Ohnishi
Nara Medical University
Nara, Japan

Objective: This experiment will provide information on how microgravity and radiation stress cells in space and affect their genetic development and shape. Two strains of slime mold cells *(Dictyostelium discoideum)*, whose distinctive development has been studied extensively on Earth, will be grown in space to identify any differences.

Significance: Slime molds, found among decaying forest leaves and in topsoil, emerge from spores. During cell differentiation, (the process through which the molds attain their adult form) the spores show very distinct structural changes at various stages of cell division. Scientists are quite familiar with these structural stages on Earth, so comparisons with cells grown in orbit should provide extensive insight into how cell development and differentiation are affected by the space environment.

Operations: This experiment will grow a radiation-sensitive strain of slime mold and a wild-type strain which should be capable of DNA repair against radiation damage. Comparison of the two strains' development will help distinguish between the effects of microgravity and those of cosmic rays.

The organisms will be grown in plant cell culture chambers. Shortly after the IML-2 payload is activated, a crew member will remove the slime mold cell culture kit from its middeck locker. After attaching a radiation detector to the kit, the astronaut will place it in the middeck refrigerator/incubator.

On Flight Day 2, an astronaut will remove the slime mold kit from the refrigerator, incubate it for an hour in the Biorack incubator, then activate growth by injecting a buffer solution into the culture. The kit will be put back in the Biorack incubator, where it will remain for 4-1/2 days at 72 degrees Fahrenheit (22 degrees C). A video camera attached to the culture chamber will observe and record changes in cell shapes during growth. As they are taken, the images will be downlinked to experiment controllers on the ground.

After the flight, scientists will evaluate the health of the spores grown in space. Radiation effects will be determined by comparing the two types of slime mold.

ORBITAL ACCELERATION RESEARCH EXPERIMENT (OARE)

Payload Developer: NASA
Project Manager:
Mr. Jose L. Christian, Jr.
NASA Lewis Research Center
Cleveland, Ohio

Objective: There is no hard boundary between Earth's atmosphere and space, no line where one ends and the other begins. The planet's atmosphere is thickest at the surface and thins gradually with increasing elevation. Even the altitudes reached by the Space Shuttle are not completely devoid of air. The Shuttle travels very rapidly through this tenuous atmosphere (near vacuum), and is slightly slowed (decelerated) by friction with it. Because the density of the atmosphere changes from day to night, the amount of friction (decelerating force) varies proportionally.

The Orbital Acceleration Research Experiment (OARE) makes extremely accurate measurements of these variations and other disturbances with a sensor called an accelerometer and records them for later analysis. By analyzing these and other types of microgravity disturbances, researchers can assess the influence of Shuttle accelerations on scientific experiments carried onboard.

Significance: The OARE is an instrument that monitors and records extremely small accelerations (changes in velocity) and vibrations experienced during Space Shuttle on-orbit operations. The OARE has already flown successfully on a number of Space Shuttle missions as part of the Orbiter Experiment Program (OEX). These previous missions had two objectives: to provide scientists with important information regarding aerodynamic drag (friction with the atmosphere) and upper atmosphere density (thickness of the air at high altitudes) that is impossible to obtain on Earth, and to study the high velocity, low density flight environment known as rarefied flow aerodynamics. This basic research has helped scientists better understand the upper atmosphere and aerodynamic behavior in it.

The OARE hardware is being pressed into service once again, this time to augment the ongoing study of the Space Shuttle's acceleration environment. The OARE will extend measurements currently being provided by the Space Acceleration Measurement System (SAMS). The OARE is capable of sensing and recording accelerations on the order of one billionth the acceleration of Earth's gravity (1 nano-g) at a rate of change (frequency) of less than once per second (1 Hz). These measurements will provide a more complete picture of the microgravity (low gravity) environment in the Space Shuttle. Scientists will use this information to determine how the disturbances influence experiment behavior.

Experiment Hardware and Operations: At the heart of the OARE system is the Miniature Electrostatic Accelerometer (MESA). The MESA has a cylindrical mass (called a proof mass) suspended within the accelerometer housing. The proof mass is pulled in different directions by static electric fields applied to electrodes within the housing. When the fields exert an equal pull in all directions on the proof mass, it floats between them. This is known as electrostatic suspension. An acceleration in any direction will cause the proof mass to move with respect to its enclosure, distorting the suspending electrostatic field. These field distortions are proportional to the applied acceleration and are measured and interpreted by OARE's electronics.

The accelerometer mounts on a movable table that allows accurate alignment with respect to the Shuttle's flight direction. In-flight calibration is also made possible by the movable mounting system. During calibration of the accelerometer, any inherent accelerometer error is determined and can be compensated for in post-flight data analysis. The OARE's nano-g sensitivity makes it impossible to calibrate on Earth, since there is no place quiet (vibration free) enough at this level of acceleration.

Once activated, the OARE operates autonomously and follows a pre-programmed sequence of operation modes. For example, calibration is normally performed at regular, predetermined intervals, but a sensor saturation (an acceleration greater than the sensor is designed to measure) will trigger an automatic initialization and calibration. the OARE software conditions the acceleration data by removing frequencies above 1 Hz, and records the data on magnetic tape.

The instrument is provided by NASA's Lewis Research Center in Cleveland, Ohio.

Commercial Protein Crystal Growth

This payload is sponsored by the Office of Advanced Concepts and Technology (OACT) as part of the commercial development of space programs within the OACT Space Processing Division. The payload and payload management are with the Center for Macromolecular Crystallography located at the University of Alabama at Birmingham, a NASA Center for the Commercial Development of Space.

This is the fifth flight (CPCG-05) of the protein crystal growth secondary payloads using the Commercial Refrigerator/Incubator Module (CRIM) in the Shuttle middeck. This complement of experiments contains 60 different samples focusing on six proteins in various formulations to enhance the probabilities for successful results. The crystals will be grown using the CMC Vapor Diffusion Apparatus (VDA) which allows proteins to be processed at a temperature of four degrees C rather than the normal 22 degrees C. The lower temperature requires a longer processing time which will be satisfied by the STS-65 14-day mission duration.

Commercial partners on this experiment with the UA-B CMC are SmithKline Beecham Pharmaceuticals and Vertex Pharmaceuticals. The firms and the university are researching the development of drugs which could provide some benefit to victims of AIDS, osteoporosis and toxic shock syndrome as well as providing a better understanding of the regulation of the human immune system and antibiotic resistance.

Dr. Larry DeLucas is the Director of the Center for Macromolecular Crystallography. The UA-B protein crystal growth apparatus first flew on STS-26 in September 1988, and in various improved versions, has flown 16 previous missions, the most recent of which was STS-62 in March.

AIR FORCE MAUI OPTICAL SYSTEM

The Air Force Maui Optical System (AMOS) is an electrical-optical facility on the Hawaiian Island of Maui. No hardware is required aboard Columbia to support the experimental observations. The AMOS facility tracks the orbiter as it flies over the area and records signatures from thruster firings, water dumps or the phenomena of "Shuttle glow," a well-documented fluorescent effect created as the Shuttle interacts with atomic oxygen in Earth orbit. The information obtained by AMOS is used to calibrate the infrared and optical sensors at the facility. AMOS is a Department of Defense payload and is flown under the direction of the DOD Space Test Program.

MILITARY APPLICATIONS OF SHIP TRACKS

The Office of Naval Research (ONR) is sponsoring the Military Applications of Ship Tracks (MAST) experiment on STS-65. MAST is part of a five-year research program developed by ONR to examine the effects of ships on the marine environment. The Naval Postgraduate School, Monterey, Calif., will conduct the experiment at JSC during the mission. The objective of MAST is to determine how pollutants generated by ships modify the reflective properties of clouds. Ship tracks are observed in satellite imagery as long, narrow, curvilinear cloud features that have greater brightness than the surrounding clouds. The STS-65 crew will photograph ship tracks using handheld cameras. These high-resolution photographs will provide insight into the processes of ship track production on a global scale. MAST will help in understanding the effects of man-made aerosols on clouds and the resulting impact on the climate system. MAST is a Department of Defense payload and is being flown under the direction of the DOD Space Test Program.

Shuttle Amateur Radio EXperiment (SAREX)

Students in the U.S., Germany and Japan will have a chance to speak, via amateur radio, with astronauts aboard the Space Shuttle Columbia during STS-65. Ground-based amateur radio operators ("hams") will be able to contact the Shuttle through automated computer-to-computer amateur (packet) radio links. There also will be voice contacts with the general ham community as time permits.

Shuttle mission specialists Donald A. Thomas (call sign KC5FVF) and Robert D. Cabana (license pending) will talk with students in 13 schools in the U.S., Germany and Japan using "ham radio."

Students in the following schools will have the opportunity to talk directly with orbiting astronauts for approximately 4 to 8 minutes:

* Sacred Hearts Academy, Honolulu, HI (WH6CJU)
* Kline School, Costa Mesa, Calif. (WB6NUD)
* Mountain View School, Phoenix, AZ (WB7VVD)
* Granite Mountain Middle School, Prescott, AZ (KB7TRE)
* West Monroe High School, West Monroe, LA (N5MYH)
* Our Lady Queen of Heaven, Lake Charles, LA (N5JDB)
* Richland Elementary, Ft. Worth, TX (KB5CXR)
* West-Oak High School, Westminster, SC (KR5GZ)
* Brentwood School, Sanderville, GA (AD4ID)
* Bair Middle School, Sunrise, FL (W4ROA)
* South Seminole Middle School, Casselberry, FL (KD4SRD)
* Fronhofer-Realschule Ingolstadt, Bavaria, Germany (DG4MKR)
* Tatebayashi Children's Science Exploratorium, Gunma, Japan (JQ1GOE)

The radio contacts are part of the SAREX (Shuttle Amateur Radio EXperiment) project, a joint effort by NASA, the American Radio Relay League (ARRL), and the Radio Amateur Satellite Corporation (AMSAT).

The project, which has flown on 13 previous Shuttle missions, is designed to encourage public participation in the space program and support the conduct of educational initiatives through a program to demonstrate the effectiveness of communications between the Shuttle and low-cost ground stations using amateur radio voice and digital techniques.

Information about orbital elements, contact times, frequencies and crew operating schedules will be available during the mission from NASA, ARRL (Steve Mansfield, 203/666-1541) and AMSAT (Frank Bauer, 301/ 286-8496). AMSAT will provide information bulletins for interested parties on INTERNET and amateur packet radio. The ARRL bulletin board system (BBS) number is (203) 688-0578.

The ARRL ham radio station (W1AW) will include SAREX information in its regular voice and teletype bulletins.

Mission information will be available online from the Johnson Space Center computer bulletin board (8 N 1 1200 baud): dial (713) 244-5625. BBS information is available from the Goddard Space Flight Center amateur radio club via Internet. The address is: wa3nan.gsfc.nasa.gov.

The amateur radio station at the Goddard Space Flight Center, (WA3NAN), will operate around the clock during the mission, providing SAREX information, retransmitting live Shuttle air-to-ground audio, and retransmitting many SAREX school group contacts.

STS-65 SAREX Frequencies

Routine SAREX transmissions from the Space Shuttle may be monitored on a worldwide downlink frequency of 145.55 MHz.

The voice uplink frequencies are (except Europe):

144.91 MHz
144.93
144.95
144.97
144.99

The voice uplink frequencies for Europe only are:

144.70
144.75
144.80

Note: The astronauts will not favor any one of the above frequencies. Therefore, the ability to talk with an astronaut depends on selecting one of the above frequencies chosen by the astronaut.

The worldwide amateur packet frequencies are:

Packet downlink	145.55 MHz
Packet uplink	144.49 MHz

The Goddard Space Flight Center amateur radio club planned HF operating frequencies:

3.860 MHz	7.185 MHz
14.295	21.395
28.650	

STS-65 CREW BIOGRAPHIES

Robert D. Cabana, 45, Col., USMC, will be Commander (CDR) of STS-65. Selected as an astronaut in 1985, Cabana was born in Minneapolis, Minn., and will be making his third space flight.

Cabana graduated from Washburn High School, Minneapolis, in 1967 and received a bachelor's degree in mathematics from the Naval Academy in 1971.

Cabana completed naval flight officer training in 1972 and then served as an A-6 bombardier/navigator with Marine Air Wings, Cherry Point, N.C., and Iwakuni, Japan, until 1975. He then completed pilot training and was designated a naval aviator in 1976, and assigned to Cherry Point where he flew A-6 Intruders. In 1981, he graduated from the Naval Test Pilot School and later served at the Naval Air Test Center as the A-6 program manager, X-29 advanced technology demonstrator project officer, and as a test pilot for flight systems and ordnance separation testing on the A-6 and A-4 aircraft. At the time of his selection by NASA, he was serving as the assistant operations officer of Marine Aircraft Group Twelve in Iwakuni.

Cabana's first Shuttle flight was as pilot of STS-41 in October 1990, a mission that deployed the Ulysses planetary probe to study the polar regions of the Sun. He next flew as pilot of STS-53 in December 1992, a mission that deployed the classified Department of Defense-1 payload.

Cabana has logged more than 273 hours in space and more than 4,700 flying hours in 32 different types of aircraft.

James Donald Halsell, Jr., 37, Lt. Col., USAF, will serve as Pilot of STS-65.

Selected as an astronaut in 1990, Halsell was born in Monroe, La., and will be making his first space flight.

Halsell graduated from West Monroe High School in 1974; received a bachelor's degree in engineering from the Air Force Academy in 1978; received a master's degree in management from Troy University in 1983; and received a master's degree in space operations from the Air Force Institute of Technology in 1985.

Halsell completed undergraduate pilot training at Columbus Air Force Base, Mississippi, in 1979 and was assigned to Nellis Air Force Base, Las Vegas, Nev., as an F-4D aircraft commander. In 1981, he was stationed at Moody Air Force Base, Valdosta, Ga., serving as squadron flight lead, instructor pilot, strike package commander and chief of the Squadron Standardization/Evaluation Branch. Later, as a student at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Dayton, Oh., his master's thesis prototyped a space rescue transfer vehicle using off-the-shelf equipment and was sponsored by the Johnson Space Center's (JSC) Crew Systems Division. Halsell then attended the Air Force Test Pilot School at Edwards Air Force Base, Calif., serving as a test pilot in the F-4, F-16 and the SR-71 aircraft in the years following his graduation.

Richard J. Hieb, 38, will be Payload Commander and Mission Specialist 1 (MS1). Selected as an astronaut in 1985, Hieb was born in Jamestown, N.D., and will be making his third space flight.

Hieb graduated from Jamestown High School in 1973; received a bachelor's degree in math and physics from Northwest Nazarene College in 1977; and received a master's degree in aerospace engineering from the University of Colorado in 1979.

Hieb joined NASA in 1979, working at JSC in crew procedures development and crew activity planning. He worked on the ascent team in Mission Control for STS-1 and during rendezvous phases of many subsequent missions, specializing in rendezvous and proximity operations.

He first flew as a Mission Specialist on STS-39 in May 1991, a Department of Defense mission that deployed and later retrieved the Infrared Background Signature Survey satellite. His next flight was as a Mission Specialist on STS-49 in May 1992, a mission that retrieved and repaired the stranded Intelsat VI F3 communications satellite. During that flight, Hieb performed three space walks totaling more than 17 hours for the capture and repair of the satellite.

Hieb has logged more than 400 hours in space.

Carl E. Walz, 38, Lt. Col., USAF, will be Mission Specialist 2 (MS2). Selected as an astronaut in 1990, Walz was born in Cleveland, Oh., and will be making his second space flight.

Walz graduated from Charles F. Brush High School, Lyndhurst, Oh., in 1973; received a bachelor's degree in physics from Kent State University in 1977; and received a master's degree in solid state physics from John Carroll University in 1979.

Walz was commissioned in the Air Force following graduation from Kent State, and after completing graduate studies at John Carroll, he was assigned to the 1155th Technical Operations Squadron at McClellan Air Force Base, Calif. In 1983, he attended the Air Force Test Pilot School at Edwards Air Force Base, Calif., as a flight test engineer, and he was assigned to the F-16 Combined Test Force at Edwards following graduation.

Walz' first Shuttle flight was as a Mission Specialist on STS-51 in September 1993, a mission that deployed the Advanced Communications Technology Satellite. Walz has logged more than 236 hours in space.

Leroy Chiao, Ph.D., 33, will be Mission Specialist 3 (MS3). Selected as an astronaut in 1990, Chiao considers Danville, Calif., his hometown and will be making his first space flight.

Chiao graduated from Monte Vista High School in Danville in 1978; received a bachelor's degree in chemical engineering from the University of California, Berkeley, in 1983; and received a master's degree and a doctorate in chemical engineering from the University of California, Santa Barbara, in 1985 and 1987, respectively.

In 1987, Chiao joined the Hexcel Corporation in Dublin, Calif., working in process, manufacturing and engineering research on advanced aerospace materials. Chiao joined the Lawrence Livermore National Laboratory in 1989 and performed processing research on filament-wound and thick-section aerospace composites. Chiao developed and demonstrated a mechanistic cure model for graphite fiber/epoxy composite material.

Chiao's technical assignments as an astronaut have included Shuttle flight software verification and work with crew equipment design issues.

Donald A. Thomas, Ph.D., 39, will be Mission Specialist 4 (MS4). Selected as an astronaut in 1990, Thomas was born in Cleveland, Oh., and will be making his first space flight.

Thomas graduated from Cleveland Heights High School in 1973; received a bachelor's degree in physics from Case Western Reserve University in 1977; and received a master's degree and a doctorate in materials science from Cornell University in 1980 and 1982, respectively.

Thomas joined AT&T Bell Laboratories in 1982 as a senior member of the technical staff, working on high density interconnections of semiconductor devices. He also served as an adjunct professor in the Trenton State College Physics Department.

In 1987, he joined Lockheed Engineering and Sciences Company in Houston where his work involved reviewing materials for Shuttle payloads. He joined NASA in 1988 as a materials engineer at JSC, performing work that involved lifetime projections of advanced composite materials for use on space station. He also was a principal investigator for the Microgravity Disturbances Experiment, a crystal growth experiment which flew on STS-32 in January 1990.

Thomas' technical assignments in the Astronaut Office have included working as a spacecraft communicator in Mission Control and as a representative to the safety and operations development branches.

Chiaki Naito-Mukai, M.D., Ph.D., 41, will be Payload Specialist 1 (PSI). Selected as a science astronaut by the National Space Development Agency of Japan (NASDA) in 1985, Mukai was born in Tatebayashi, Gumma Prefecture, Japan, and will be making her first space flight.

Mukai graduated from Keio Girls' High School, Tokyo, in 1971; received her doctor of medicine degree from Keio University School of Medicine in 1977;

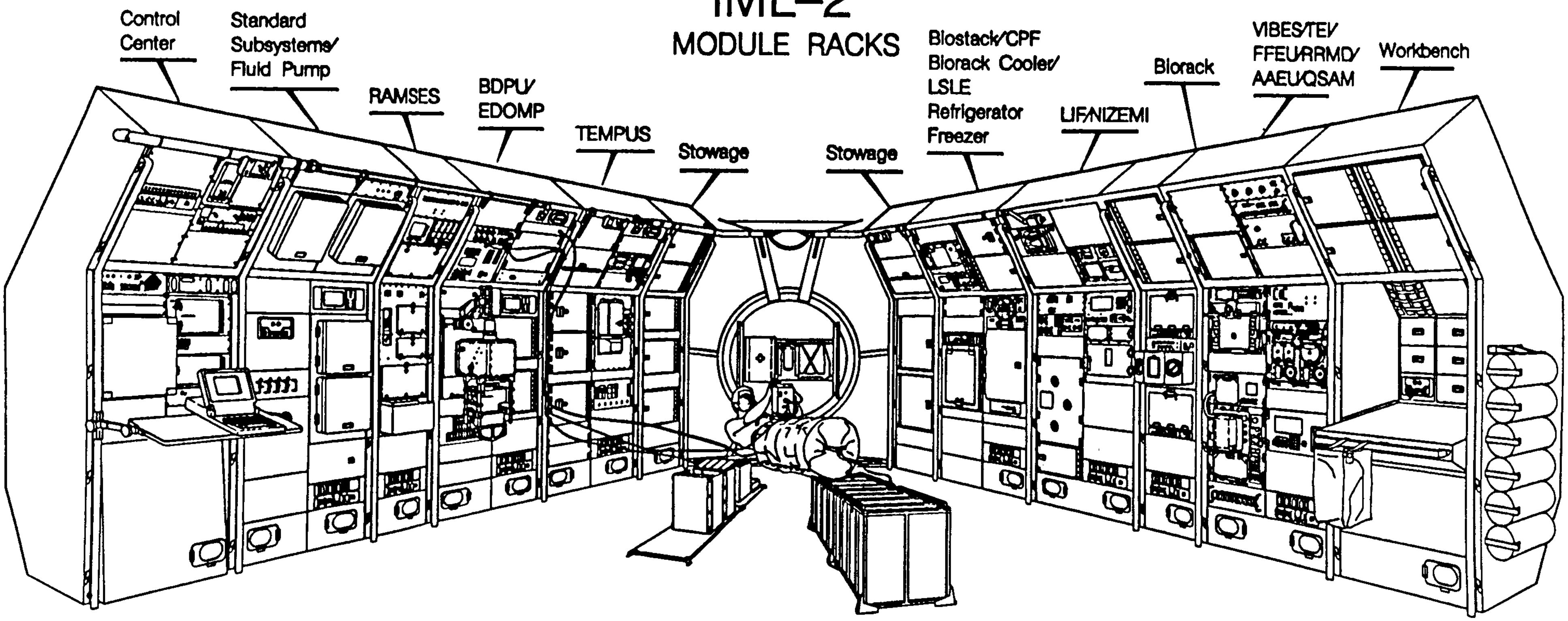
and received a doctorate in physiology from the Keio University School of Medicine in 1988. She was board certified as a cardiovascular surgeon by the Japan Surgical Society in 1989.

Mukai was board certified for Clinical Medicine in 1977, and, until 1979, worked as a resident in General Surgery at Keio University Hospital, Tokyo. In 1978, she was on the medical staff in Emergency Surgery at Saiseikai Kanagawa Hospital, Kangewa Prefecture. In 1980, she began work as a resident in cardiovascular surgery at Keio University Hospital and on the medical staff of cardiovascular surgery at Saisekai Utsunomiya Hospital, Tochigi Prefecture. In 1983, she returned to Keio University Hospital as the chief resident in cardiovascular surgery and later became the assistant professor of the Department of Cardiovascular Surgery.

Mukai was selected by NASDA in 1985 as one of three payload specialist candidates for the Japanese Spacelab, Spacelab-J, on Shuttle mission STS-47. She became a visiting scientist of the Division of Cardiovascular Physiology at the Space Biomedical Research Institute at JSC from 1987 to 1988. Mukai is credited with more than 50 publications since 1979.

IML-2

MODULE RACKS



SHUTTLE FLIGHTS AS OF JUNE 1994

62 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 37 SINCE RETURN TO FLIGHT

OV-099 Challenger (10 flights)

- STS 51-L 01/28/86
- STS 61-A 10/30/85 - 11/06/85
- STS 51-F 07/29/85 - 08/06/85
- STS 51-B 04/29/85 - 05/6/85
- STS 41-G 10/5/84 - 10/13/84
- STS 41-C 04/06/84 - 04/13/84
- STS 41-B 02/03/84 - 02/11/84
- STS-8 08/30/83 - 09/05/83
- STS-7 06/18/83 - 06/24/83
- STS-6 04/04/83 - 04/09/83

OV-102 Columbia (16 flights)

- STS-62 03/04/94 - 03/18/94
- STS-58 10/18/93 - 11/01/93
- STS-55 04/26/93 - 05/06/93
- STS-52 10/22/92 - 11/1/92
- STS-50 06/25/92 - 07/09/92
- STS-40 06/05/91 - 06/14/91
- STS-35 12/02/90 - 12/10/90
- STS-32 01/09/90 - 01/20/90
- STS-28 08/08/89 - 08/13/89
- STS 61-C 01/12/86 - 01/18/86
- STS-9 11/28/83 - 12/08/83
- STS-5 11/11/82 - 11/16/82
- STS-4 06/27/82 - 07/04/82
- STS-3 03/22/82 - 03/30/82
- STS-2 11/12/81 - 11/14/81
- STS-1 04/12/81 - 04/14/81

OV-103 Discovery (18 flights)

- STS-60 02/03/94 - 02/11/94
- STS-51 09/12/93 - 09/22/93
- STS-56 04/08/93 - 04/17/93
- STS-53 12/2/92 - 12/9/92
- STS-42 01/22/92 - 01/30/92
- STS-48 09/12/91 - 09/18/91
- STS-39 04/28/91 - 05/06/91
- STS-41 10/06/90 - 10/10/90
- STS-31 04/24/90 - 04/29/90
- STS-33 11/22/89 - 11/27/89
- STS-29 03/13/89 - 03/18/89
- STS-26 09/29/88 - 10/03/88
- STS 51-I 08/27/85 - 09/03/85
- 51-G 06/17/85 - 06/24/85
- 51-D 04/12/85 - 04/19/85
- STS 51-C 01/24/85 - 01/27/85
- STS 51-A 11/08/84 - 11/16/84
- STS 41-D 08/30/84 - 09/04/84

OV-104 Atlantis (12 flights)

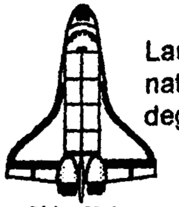
- STS-46 7/31/92 - 8/8/92
- STS-45 03/24/92 - 04/02/92
- STS-44 11/24/91 - 12/01/91
- STS-43 08/02/91 - 08/11/91
- STS-37 04/05/91 - 04/11/91
- STS-38 11/15/90 - 11/20/90
- STS-36 02/28/90 - 03/04/90
- STS-34 10/18/89 - 10/23/89
- STS-30 05/04/89 - 05/08/89
- STS-27 12/02/88 - 12/06/88
- STS 61-B 11/26/85 - 12/03/85
- STS 51-J 10/03/85 - 10/07/85

OV-105 Endeavour (6 flights)

- STS-59 04/09/94 - 04/20/94
- STS-61 12/2/93 - 12/13/93
- STS-57 6/21/93 - 7/1/93
- STS-54 01/13/93 - 01/19/93
- STS-47 09/12/92 - 09/20/92
- STS-49 05/07/92 - 05/16/92

Upcoming Space Shuttle Flights

Columbia **STS-65** **1994** **Pad 39-A**

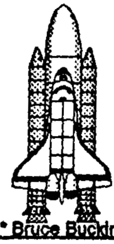


Launch targeted for July. Primary payload is the International Microgravity Laboratory-2. Inclination 28.45 degrees/185 st. miles. 13 days. Robert D. Cabana; James D. Halsell Jr.; Richard J. Hieb; Leroy Chiao; Donald A. Thomas; Carl E. Walz; Chiaki Mukai.

Landing: KSC

* Lisa Malone

Endeavour STS-67 1995 Pad 39-B

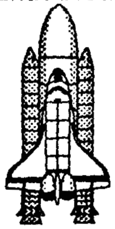


Launch targeted for January. Payload is ASTRO-2. Crew: Stephen S. Oswald; William C. Gregory; Tamara E. Jernigan (PC); John M. Grunsfeld; Wendy B. Lawrence; Ronald A. Parise; Samuel T. Durrance. Inclination 28.45 degrees/218 st. miles. Duration 13 days, 14 hours.

Landing: KSC

* Bruce Buckingham

Endeavour STS-68 1994 Pad 39-A

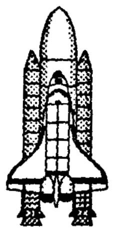


Launch targeted for August. Payload includes Space Radar Laboratory-2. Inclination 57 degrees/138 st. miles. Nine days. Crew: Michael A. Baker; Terrence W. Wilcutt; Thomas D. Jones (PC); Steven L. Smith; Peter J. K. Wisoff; Daniel W. Bursch.

Landing: KSC

* Bruce Buckingham

Discovery STS-63 1995 Pad 39-A

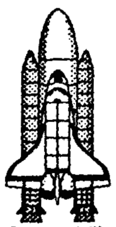


Launch targeted for February. Payload is SPACEHAB-3, Spartan-204, Concap-II, and CGP/ODERACS-2. Mir fly around. Inclination 51.60 degrees/195 st. miles. 8 days. Crew: James D. Wetherbee, Eileen M. Collins, C. Michael Foale, Janice S. Voss, Bernard A. Harris, Vladimir Titov.

Landing: KSC

* George Diller

Discovery STS-64 1994 Pad 39-B

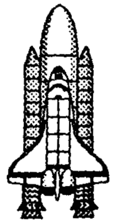


Launch targeted for September. Payload includes Lidar-In-space Technology Experiment (LITE). Inclination 57 degrees/161 st. miles. Nine days. Crew: Richard N. Richards; L. Blaine Hammond Jr.; Carl J. Meade; Mark C. Lee; Susan J. Helms; Jerry M. Linenger.

Landing: KSC

* George Diller

Endeavour STS-69 1995 Pad 39-B

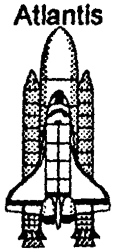


Launch targeted for May. Payloads are WSF-2, OAST, IEH-1, and GBA. Inclination 28.45 degrees/190 st. miles. Ten days. Crew: James S. Voss - no others assigned as of this date.

Landing: KSC

* Lisa Malone

Atlantis STS-66 1994 Pad 39-A

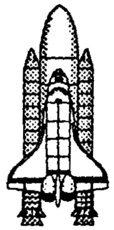


Launch targeted for October. Payloads include Atlas-3, CRISTA-SPAS, SSBUV/A-3. Inclination 57 degrees/188 st. miles. 11 days. Crew: Donald R. McMonagle; Curtis L. Brown; Ellen Ochoa (PC); Scott E. Parazynski; Joseph R. Tanner; Jean-Francois Clervoy.

Landing: KSC

* Lisa Malone

Atlantis STS-71 1995 Pad 39-A



Launch targeted for May. This will be the first MIR docking. Crew will be 5 NASA/2 Russians going up and 6 NASA/2 Russians coming back. Crew members have not been assigned. Inclination 51.6 degrees/195-237 st. miles. Nine day flight.

Landing: KSC

* Bruce Buckingham

NOTES ON THIS SCHEDULE: This is an unofficial Space Shuttle launch schedule covering the period from June 1994 through May 1995. Crew listing names commanders first, then pilots, then mission and payload specialists. This flight listing is based on April 1994 Mixed Fleet Manifest. This graph is prepared by the Kennedy Space Center Media Services Branch and is dated June 1, 1994. Abbreviations used include: * = Public Affairs Commentator. PC = Payload Commander. Official launch dates are set at [illegible] Review.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Edward Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1778)

Kyle Herring
Johnson Space Center, Houston
(Phone: 713/483-5111)

For Release
June 17, 1994

RELEASE: 94-97

ASTRONAUT BOLDEN RETURNS TO MARINE CORPS

Four-time Space Shuttle Astronaut Charles F. Bolden, Jr., (Colonel, USMC) will leave NASA and return to active duty in the U.S. Marine Corps as the Deputy Commandant of Midshipmen at the Naval Academy, Annapolis, Md., effective June 27.

Bolden leaves NASA after 14 years. He was selected to be an astronaut in 1980 and held several technical assignments within the Astronaut Office prior to his first Shuttle flight in January 1986 aboard Columbia on the STS 61-C mission. During the six-day flight, the crew deployed a communications satellite and conducted several experiments in astrophysics and materials processing.

His second flight was aboard Discovery on the STS-31 mission to deploy the Hubble Space Telescope in April 1990. As commander of Atlantis' STS-45 mission in March 1992, Bolden watched over the orbiter during the conduct of 12 experiments that made up the first Atmospheric Laboratory for Applications and Science (ATLAS-1) payload. The mission was the first dedicated to NASA's Mission to Planet Earth.

Bolden's final Shuttle mission was in February aboard Discovery on the STS-60 flight. The mission marked the first joint U.S./Russian Shuttle flight with a cosmonaut flying as a crew member. It was the second flight of the Spacehab middeck augmentation module and the first flight of the Wake Shield Facility designed to evaluate the effectiveness of growing semiconductors, high temperature superconductors and other materials using the ultra-high vacuum created behind the spacecraft near the experiment package.

-more-

"It is with mixed emotions that we say goodbye to Charlie, but we wish him well at Annapolis," said David C. Leestma, Flight Crew Operations Director. "Having served as a crew member with him, I saw a clear demonstration of the leadership qualities he has. While we will miss Charlie, he certainly has left a positive mark, not only on the astronaut corps, but on everyone who knows him throughout NASA."

In his new role as Deputy Commandant of Midshipmen, Bolden will assist the Commandant with the formulation and execution of Naval Academy policy. He will be responsible for the execution of the day-to-day routine of the Brigade. Bolden also will coordinate and direct the training of the Brigade Officers.

In addition to flying more than 680 hours during his four space missions, Bolden has logged over 6,000 hours flying time in various aircraft, including the A-6A and A-6E, the EA-6B, the A-7C/E and several NASA training aircraft.

Bolden, 47, graduated from the Naval Academy in 1968 with a bachelor of science degree in electrical science. He received a master of science degree in systems management from the University of Southern California in 1977.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Michael Braukus
Headquarters, Washington, D.C.
(Phone: 202/358-1979)

David Drachlis
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/544-0034)

For Release
June 20, 1994

RELEASE: 94-98

NASA SELECTS PAYLOAD SPECIALISTS FOR SPACELAB MISSION

The National Aeronautics and Space Administration today announced the selection of Dr. Fred W. Leslie of NASA's Marshall Space Flight Center, (MSFC) Huntsville, Ala., and Dr. Albert Sacco, Jr., of Worcester Polytechnic Institute, Worcester, Mass., to fly as payload specialists on the second United States Microgravity Laboratory (USML-2) mission. USML-2 is a 16-day Spacelab mission scheduled for flight aboard the Space Shuttle Columbia in Sept. 1995.

Dr. Leslie, 43, earned a Ph.D in atmospheric science with a minor in fluid dynamics from the University of Oklahoma. He is chief of the MSFC Earth System Processes and Modeling branch. He resides in Huntsville, Ala.

Dr. Sacco, of Holden, Mass., earned a Ph.D in chemical engineering from the Massachusetts Institute of Technology. He is a professor and head of the chemical engineering department at Worcester Polytechnic Institute. The 44-year-old Sacco was an alternate payload specialist for the USML-1 mission.

NASA has designated Dr. R. Glynn Holt of NASA's Jet Propulsion Laboratory, Pasadena, Calif., and Dr. David H. Matthiesen of Case Western Reserve University, Cleveland, Ohio, to serve as alternates to Leslie and Sacco.

During the mission, Leslie and Sacco will conduct more than 30 scientific and technological investigations in materials, fluids and biological processes in the orbiting laboratory. They will be supported by Holt and Matthiesen, who will serve as key control team members in the Spacelab Mission Operations Control facility at MSFC.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Charles Redmond
Headquarters, Washington, D.C.
(Phone: 202/358-1757)

For Release
June 21, 1994

RELEASE: 94-99

NASA ANNOUNCES 1994 PHASE ONE STTR SELECTIONS

NASA's Office of Advanced Concepts and Technology today announced the selection of six research proposals for immediate negotiation of 1994 Phase I contracts in the Small Business Technology Transfer Program (STTR).

The 1994 Phase I solicitation closed on March 3, 1994. Twenty-nine separate proposals were received from 28 small, high technology businesses from all sections of the United States in response to the specific topic of interactive document and data review tools.

The STTR program is similar to the Small Business Innovative Research program but varies by allowing universities, federal laboratories and non-profit organizations to apply in cooperation with small business partners. The STTR program also is more directly aimed at private sector commercialization activities, with Phase I projects geared toward product development and Phase II projects geared toward product commercialization.

Experts from NASA's Goddard Space Flight Center, Greenbelt, Md., academia, and commercial businesses reviewed the proposals for technical merit and commercial potential. Each of the six selected proposals in this round will be awarded fixed-price contracts valued at up to $100,000 with 12 months to complete the Phase I projects.

Companies which successfully complete Phase I activities become eligible to compete for Phase II awards the following year. The Phase II award process allows for two-year, fixed-price contracts up to $500,000.

NASA also will select approximately 14 additional proposals from those submitted in the other topic categories of general aviation instrumentation and systems, and small-scale robotics. These additional selections will be made in late June.

- more -

Firms and their partners selected for negotiation of Phase I contracts in this first round of the 1994 STTR Program are:

(proposal, firm and address, partner(s) and addresses)

1. Director Based System for Administering High Quality Software Repositories; Interconnect Technologies Corp., P.O. Box 4158, Mountain View, Calif. 94040-0148; Stanford University, Computer Science Dept., Stanford, Calif. 94305.

2. Automated Capture of Technical Manuals into IETM Format for Electronic Review and Distribution; Cybernet Systems Corp., 1919 Green Rd., Suite B-101, Ann Arbor, Mich. 48105; University of Michigan, 2901 Hubbard St., Ann Arbor, Mich. 48109-2106.

3. Interactive Archive for Data Standards; Interactive Archives Inc., 11324 Cherry Hill Rd., Unit 202, Beltsville, Md. 20705; University of Colorado, Campus Box 590, Boulder, Co. 80309.

4. Distributed Environment for Interactive Document and Data Review; Diginet Research Inc., 3019 Orchard Hill, San Antonio, TX 78230; University of Houston, 4800 Calhoun Rd., Houston, Texas 77204.

5. An Interactive Information Exchange and Retrieval Tool; Innovative Aerodynamic Technologies; 534-C Wythe Creek Rd., Poquoson, Va. 23662; Old Dominion University, Hampton Blvd., Norfolk, Va. 23529.

6. A Data Publishing System (DPS) for NASA Earth and Space Science Datasets; Grafikon Ltd., 11329 Classical Ln., Silver Spring, Md. 20901; University of Maryland, Dept. of Astronomy, College Park, Md. 20742.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Michael Braukus
Headquarters, Washington, D.C.
(Phone: 202/358-1979)

For Release

June 22, 1994

RELEASE: 94-100

NASA SELECTS SCIENTISTS FOR NEUROLAB SHUTTLE MISSION

NASA announced today the selection of 34 scientists who will participate in the experiment definition phase of the Neurolab Space Shuttle mission. Neurolab, a 14 to 16-day joint Shuttle mission with the National Institutes of Health (NIH) devoted to brain and behavioral research, is scheduled for launch in early 1998.

The 34 investigators were selected from over 170 scientists from around the world who submitted proposals for experiments to be conducted on the mission. All of the proposals underwent rigorous peer review conducted by the NIH Division of Research Grants which evaluated them for their scientific merit. The chosen studies were deemed to be the best experiments that could be accommodated on the Space Shuttle. The selected scientists are from the United States, Japan, France, Canada, Italy, Germany, the Netherlands and Nigeria.

The Neurolab scientists will be organized into investigator teams, based on the scientific areas of their research. Examples of topics that will be studied include how the brain develops in microgravity, how the sense of balance and control of movement is altered in microgravity and what effects the space environment has on sleep and the body's biological rhythms. The teams will undergo a ten-month science definition period during which time each team will produce an integrated research plan based on the original proposals. After the science definition period, the integrated research plans will once again be reviewed to ensure that the experiments to be conducted on the mission are of the highest quality.

The Neurolab Mission is being carried out by NASA in cooperation with a variety of domestic and international partners. The major domestic partner is the NIH, specifically the National Institute on Aging, the National Institute on Deafness and Other Communication Disorders, the National Heart, Lung, and Blood

- more -

Institute, the National Institute of Neurological Disorders and Stroke, the National Institute of Child Health and Human Development and the Division of Research Grants. The National Science Foundation and the Office of Naval Research also are domestic partners. International partners include the European Space Agency and the space agencies of Japan, France, Germany and Canada. The partners are supporting the mission by providing some funding for the scientists, supplying scientific equipment to be used on the Space Shuttle and participating in mission planning.

The Neurolab scientists whose experiments were selected for definition are:

Friedhelm J. Baisch, M.D.
DLR Institute of Aerospace Medicine
Cologne, Germany

Kenneth M. Baldwin, Ph.D.
University of California, Irvine
Irvine, Calif.

Alain Berthoz, Ph.D.
CNRS/Collège de France
Paris, France

Ingrid M. Block, Ph.D.
DLR German Space Research Institute
Cologne, Germany

C. Gunnar Bloomqvist, M.D., Ph.D.
University of Texas Southwestern Medical Center
Dallas, Texas

Otmar Bock, M.D.
Institute of Space & Terrestrial Science
Ontario, Canada

Scott T. Brady, Ph.D.
University of Texas Southwestern Medical Center
Dallas, Texas

Barbara Chapman, Ph.D.
California Institute of Technology
Pasadena, Calif.

Gilles R. Clement, Ph.D.
National Center for Scientific Research
Paris, France

Bernard Cohen, M.D.
Mount Sinai School of Medicine
New York, N.Y.

Charles A. Czeisler, M.D., Ph.D.
Harvard Medical School/Brigham & Women's Hospital
Cambridge, Mass.

Dwain L. Eckberg, M.D.
Medical College of Virginia
Richmond, Va.

Charles A. Fuller, Ph.D.
University of California, Davis
Davis, Calif.

Stephen M. Highstein, M.D., Ph.D.
Washington University
St. Louis, Mo.

Gay R. Holstein, Ph.D.
Mount Sinai School of Medicine
New York, N.Y.

Eberhard R. Horn, Ph.D.
University of Ulm
Ulm, Germany

Bruce G. Jenks, Ph.D.
University of Nijmegen
Nijmegen, Netherlands

Haig S. Keshishian, Ph.D.
Yale University
New Haven, Conn.

Kenneth S. Kosick
Harvard Medical School/Brigham & Women's Hospital
Cambridge, Mass.

Bruce L. McNaughton, Ph.D.
University of Arizona
Tucson, Ariz.

Philip C. Njemanze, M.D.
Chidicon Medical Center
Owerri, Nigeria

Richard S. Nowakowski, Ph.D.
UMDNJ-Robert Wood Johnson Medical School
Piscataway, N.J.

Charles M. Oman, Ph.D.
Massachusetts Institute of Technology
Cambridge, Mass.

Ottavio Pompeiano, M.D.
University of Pisa
Pisa, Italy

Jaqueline Raymond, Ph.D.
University of Montpellier
Montpellier, France

Danny A. Riley, Ph.D.
Medical College of Wisconsin
Milwaukee, Wis.

David Robertson, M.D.
Vanderbilt University School of Medicine
Nashville, Tenn.

Muriel D. Ross, Ph.D.
NASA Ames Research Center
Moffett Field, Calif.

Tsuyoshi Shimizu, M.D., Ph.D.
Fukushima Medical College
Fukushima City, Japan

Tracey J. Shors, Ph.D.
Princeton University
Princeton, N.J.

Shiro Usui, Ph.D.
Toyohashi University of Technology
Aichi, Japan

Kerry Walton, Ph.D.
New York University Medical Center
New York, N.Y.

John B. West, M.D., Ph.D.
University of California, San Diego
San Diego, Calif.

Michael L. Wiederhold, Ph.D.
University of Texas Health Center at San Antonio
San Antonio, Texas

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

For Release

June 23, 1994

Ed Campion
Headquarters, Washington, D.C.
(Phone: 202/358-1778)

Bruce Buckingham
Kennedy Space Center, Fla.
(Phone: 407/867-2468)

NOTE TO EDITORS: N94-45

NASA SETS JULY 8th AS DATE FOR NEXT SHUTTLE LAUNCH

NASA managers today set July 8 as the official launch for the agency's next Space Shuttle mission -- designated as STS-65. Space Shuttle Columbia and a seven person crew, which includes the first Japanese female to fly in space, will conduct the second flight of the International Microgravity Laboratory (IML-2) payload.

The STS-65 mission involves a world-wide research effort into the behavior of materials and life in the weightless environment of Earth-orbit. Data gathered during the IML-2 mission may help researchers develop the next generation of materials needed for high-tech applications and will provide scientists with insights about life in space which in turn can increase knowledge of the factors which govern life and health on Earth.

The IML-2 mission is an international effort with scientists from NASA, the European Space Agency (ESA), the French Space Agency (CNES), the German Space Agency (DARA), the Canadian Space Agency (CSA) and the National Space Development Agency of Japan (NASDA) cooperating in planning the experiments which will be performed during the STS-65 mission. More than 200 scientists developed some 100 investigations for the IML-2 mission.

The launch on July 8 is currently planned for 12:43 p.m. EDT at the start of a 2 1/2 hour available window. The planned mission duration is 13 days, 17 hours, 56 minutes. An on-time launch on July 8 would produce a landing at approximately 6:40 a.m. EDT on July 22, 1994 at the Kennedy Space Center's Shuttle Landing Facility.

STS-65 will be the 17th flight of Space Shuttle Columbia and the 63rd flight of the Space Shuttle system.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Debra J. Rahn
Headquarters, Washington, D.C.
(Phone: 202/358-1639)

For Release
June 23, 1994

RELEASE: 94-101

NASA AND RUSSIAN SPACE AGENCY SIGN SPACE STATION INTERIM AGREEMENT AND $400 MILLION CONTRACT

NASA and the Russian Space Agency (RSA) signed two significant documents today which put the United States and Russian space cooperation on a firm basis and underpin Russian participation in the International Space Station program.

NASA and RSA signed an "Interim Agreement for the Conduct of Activities Leading to Russian Partnership in Permanently Manned Civil Space Station" that provides for initial Russian participation in the International Space Station program. The Interim Agreement will govern Russian participation until an Intergovernmental Agreement (IGA) and a NASA-RSA Memorandum of Understanding can be concluded.

"This interim agreement is an essential step toward Russia's full participation in the International Space Station project. Just as the race to the moon defined the Cold War competition between the superpowers, the Space Station will define a new era of peace and cooperation for the world," said Daniel S. Goldin, NASA Administrator.

NASA and RSA also signed a separate $400 million contract for Russian space hardware, services and data. Under this contract, NASA will purchase hardware and services from RSA and its subcontractors for approximately $100 million per year through 1997 in support of a joint program involving the U.S. Space Shuttle and the Russian Mir Space Station. The contract also covers early International Space Station activities.

The Interim Agreement and $400 million contract were separately signed by NASA Administrator Daniel S. Goldin and RSA Director General Yuri Koptev at a formal signing ceremony in Washington D.C. at the conclusion of the U.S.-Russian Joint Commission on Economic and Technological Cooperation meeting presided over by Vice President Gore and Prime Minister Chernomyrdin.

-more-

NASA/RSA Interim Agreement

The Interim Agreement establishes bilateral management mechanisms which are fully consistent with existing management mechanisms utilized by the International Space Station partners. It also provides for Russian participation in the existing multinational Space Station management mechanisms.

The agreement establishes, among other things, a NASA/RSA Program Coordination Committee which will review design and development activities during this initial cooperation. It also provides for RSA's participation on the Space Station Control Board, along with the other partners, which controls the Space Station requirements, configuration, and interfaces through the completion of assembly and initial operational verification. RSA also will be included in the Multilateral Coordination Board which ensures coordination of the operation and utilization activities of the Space Station.

The agreement provides for the establishment of Space Station technical liaison offices in Moscow and Houston for purposes of facilitating the working relationships between NASA and RSA.

Multilateral negotiations involving Russia and other Space Station partners on a protocol amending the Space Station Intergovernmental Agreement are currently underway. Negotiations on the NASA-RSA Memorandum of Understanding will begin later this summer.

NASA/RSA $400 Million Contract

Activities included in this Contract expand on an ongoing cooperative program under the Human Space Flight Agreement. That agreement, concluded in 1992, provides for a U.S. astronaut flight on Mir for three months and a Space Shuttle to dock with Mir in 1995. Key elements of the $400 million Contract include:

o U.S. astronauts will spend up to 21 additional months on board the Russian Mir station, giving a new generation of American astronauts and scientists their first experience with long-duration space flight.

o The U.S. Space Shuttle will dock as many as nine additional times with the Mir station, delivering astronauts and research instruments. NASA will gain fundamental experience in joint operations: risk reduction, command and control, docking the Shuttle with large structures in space, performing technology experiments, and executing a joint research program.

o The implementation of a joint research program onboard Mir, including astronauts and cosmonauts and U.S. and Russian experiments. The Russian Spektr and Priroda research modules will be extensively used.

o The Russians will provide flight-proven equipment, including several docking mechanisms for use with Mir and later with the International Space Station.

o Joint development of Solar Thermal Dynamics, a newer and more efficient way to generate electrical power in space.

o Joint technology demonstrations of systems that may be used on the International Space Station.

o Demonstrations of joint operations and activities, such as Extravehicular Activity (EVA).

o Up to $20 million to support Russian scientists engaged in joint scientific and research programs to support science, technology and engineering on board the Mir Space Station.

o Initial development funding for the FGB module that NASA will purchase for use on the International Space Station.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Drucella Andersen
Headquarters, Washington, D.C.
(Phone: 202/358-4733)

Marcia Adams
Federal Aviation Administration, Washington, D.C.
(Phone: 202/267-8521)

Mary Sandy
Virginia Space Grant Consortium
(Phone: 804/865-0726)

For Release
June 23, 1994

RELEASE: 94-102

NASA/FAA SPONSOR GENERAL AVIATION COMPETITION

NASA and the Federal Aviation Administration (FAA) today announced their joint sponsorship of a general aviation design competition for students at U.S. aeronautical and engineering universities. The contest will challenge teams of undergraduate and graduate students -- working with faculty advisors -- to develop a multi-disciplinary design for a general aviation aircraft.

Complete competition guidelines will be available by mid-July. Designs must be submitted by May 1, 1995. Up to four cash awards totaling $11,000 will be announced at an awards ceremony in July 1995 at the annual Experimental Aircraft Association Fly-In Convention and Sport Aviation Exhibition at Oshkosh, Wisc.

"These are the types of opportunities NASA needs to develop to capture the bold initiative and innovative enthusiasm that exists in our nation's college ranks," said Dr. Wesley L. Harris, NASA's Associate Administrator for Aeronautics. "This partnership with academia -- and ultimately, industry -- represents the way we want to do business at NASA," he said.

Richard A. Weiss, the FAA's Director of General Aviation and Vertical Flight Research and Development notes, "It is the policy of the FAA to foster and promote general aviation. It is our hope that participation by universities will become an integral part of the revitalization effort now underway and that the competition will serve to stimulate breakthroughs in technology and its application."

-more-

Technologies to be addressed in the competitive designs will include integrated cockpit systems, propulsion, integrated design and manufacturing and aerodynamics. For purposes of the competition, general aviation aircraft are defined as fixed-wing, single-engine, single pilot, propeller-driven aircraft.

"Universities have drifted away from general aviation with the decline in the industry's condition. NASA and the FAA developed this competition to help reverse that trend and begin to involve faculty and students in general aviation," said Dr. Bruce J. Holmes, Manager of NASA's General Aviation Program Office, Langley Research Center, Hampton, Va.

All designs submitted in accordance with competition guidelines will be reviewed by a selection panel of representatives from NASA, the FAA and industry. All design projects will receive critical evaluation and feedback. Faculty and students are encouraged to plan now to incorporate this design challenge into fall design classes and projects. Involvement of industry advisors is encouraged, as is the participation of women and minorities on design teams. Teaming across departments and among institutions also is encouraged.

Interested faculty and students may request guidelines from: Virginia Space Grant Consortium, 2713-D Magruder Blvd., Hampton, Va. 23666. Requests may be faxed to 804/865-7965. The Consortium, a nonprofit aerospace educational coalition, is disseminating information on the competition on behalf of the sponsoring agencies.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Mark Hess
Headquarters, Washington, D.C.
(Phone: 202/358-0902)

For Release
June 24, 1994

RELEASE: 94-103

NASA ADMINISTRATOR RELEASES STATEMENT ON GAO REPORT

"This GAO report is a validation of what we've been saying for months -- Russian participation in the Space Station is a good deal for the American taxpayer," NASA Administrator Daniel S. Goldin said. "It will save hundreds of millions, if not billions of dollars. For the American taxpayer, it's a win-win situation. More Space Station for less cost."

"I'm particularly pleased with the GAO's positive assessment of how valuable the Russian contribution will be in terms of significantly improving the capability for science and engineering research. The report echoes what members of the Vest Committee said about the program. I see this report as further validation of the value the Russians bring to the Space Station program."

Goldin said the benefits of Russian cooperation include:

- the Space Station will be completed 15 months earlier, will have nearly double the volume, double the power, twice as many research modules and a larger crew
- flight-proven space hardware which would cost the U.S. billions to develop
- access to Mir for collecting valuable science
- access to Mir to check out our hardware, which reduces risk
- access to Mir to obtain early operational experience, which reduces risk

The GAO report stated that about $746 million from two extra Shuttle flights should be scored against the $2 billion in savings from Russian participation. Goldin's response was, "We're going to fly eight Shuttle missions a year. The point is, the money for those flights is in the budget; there's no additional costs due to Russian cooperation.

"For the most part, the only quibble we have with the GAO is a book-keeping issue. The fact is, every nickel is accounted for in the NASA budget, and Russian cooperation will not cost the U.S. taxpayer one penny more - in fact I believe it will save us billions."

-more-

GAO also stated that the $400 million contract with the Russian Space Agency should be counted against the $2 billion savings. Goldin said, "My personal view is the opportunity to use Mir to develop some of our own operational procedures and to test hardware in the real space environment could save us billions in the long run. As our problems with the Intelsat satellite capture and repair mission proved, there's no place like space to test out your equipment before you commit it to flight.

"The Russians bring flight-proven hardware to the program, and they have vastly more experience in long duration flight than the U.S., which will be of tremendous benefit to the International Space Station partnership," said Goldin. "They have operated seven space stations and have three times (27 man-years) the experience on orbit compared to the U.S."

Goldin added, "While there are tangible benefits to Russian cooperation, which the GAO report fairly and accurately points out, auditors cannot put a price tag on the intangible benefits of international cooperation. It's good foreign policy, and it's good space policy. The Cold War is over, and cooperation with the Russians demonstrates that former adversaries can join forces in a peaceful pursuit which will generate tremendous benefits for both nations."

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Donald Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Michael Finneran
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-5565)

Lynn Simarski
National Science Foundation, Arlington, Va.
(Phone: 703/306-1070)

Ray Villard
Space Telescope Science Institute, Baltimore, Md.
(Phone: 410/338-4514)

For Release

June 27, 1994

NOTE TO EDITORS: N94-46

NEWSROOM HOURS AND TV COVERAGE FOR COMET SHOEMAKER-LEVY 9

NASA's coverage of the impact of Comet P/Shoemaker-Levy 9 during the week of July 16-22 includes a series of live, televised press briefings and a 24-hour newsroom operation at the Goddard Space Flight Center (GSFC), Greenbelt, Md.

The Goddard Comet Impact newsroom will be the central location providing coverage of observations and images from the worldwide network of ground-based observatories and spacecraft taking part in the NASA/National Science Foundation observing project. Scientists will be on hand at the newsroom to answer questions, or interviews can be arranged as needed. Press materials, artwork and video relating to the event will be available to media.

The first fragment of the comet will impact Jupiter just before 4 p.m. EDT on the side of Jupiter facing away from Earth. Shortly afterwards, the point of impact will rotate into view as seen from Earth. The first image of the impact area is expected to be available (following minimal processing) at about 10 p.m. EDT.

NASA will release the image in a live program broadcast from the Space Telescope Science Institute, Baltimore, Md., starting at 10 p.m. EDT. There will be no press briefing on NASA TV at that time, however, a briefing will be held Sunday morning at the Goddard Comet Impact Newsroom.

- more -

Press Briefing Schedule

At 8:00 a.m. EDT, Sunday, July 17, a press briefing will be broadcast live on NASA TV with Q & A from other NASA Centers, and will include updated information about the first impact and the image. During the following week, NASA will hold a live press briefing each day at the GSFC Comet Impact Newsroom (see schedule below).

The briefing panels will include Comet co-discoverers Drs. Eugene and Carolyn Shoemaker and David Levy on most days as well as scientists presenting images and information from the Hubble Space Telescope and other spacecraft. Dr. Lucy McFadden will have a round-up of observations from ground-based observatories around the world. The program and briefing schedule follows:

JULY	DATE	TIME (EDT)	EVENT
Sat.	16	10:00 p.m.	Live from HST: First Impact Image Release (no Q & A from NASA Centers)
Sun.	17	8:00 a.m.	Press Briefing at GSFC
Mon.	18	8:00 a.m.	Press Briefing at GSFC
Tue.	19	8:00 a.m.	Press Briefing at GSFC
Wed.	20	12:00 noon	Press Briefing at GSFC
Th.	21	8:00 a.m.	Press Briefing at GSFC
Fri.	22	9:30 a.m.	Press Briefing at GSFC
Sat.	23	8:00 a.m.	Press Briefing at GSFC

Note: The above times are dependent on the STS-65 mission schedule. If there is a change in the launch or landing time of the Shuttle, the program times will change.

Comet Impact Newsroom Operations

The newsroom will operate on a 24-hour basis beginning at 6 a.m., Sun., July 17 until noon EDT, July 23. The newsroom will be located at the Goddard Visitor's Center on Soil Conservation Road in Greenbelt. The phone number for the newsroom will be 301/286-2300, but will not be active until 6 a.m., July 17.

Media wishing to use the newsroom must register at the Visitor Center and obtain a media badge, starting at 6 a.m. EDT July 17. Valid press credentials and a photo ID must be presented. Media representatives who are not U.S. citizens must contact the Goddard Office of Public Affairs at 301/286-8955 before registering.

Video Uplink Schedule

NASA will provide feeds of b-roll and animation of the comet impacts with Jupiter on the following schedule:

June 29:	10:00 a.m. and 1:30 p.m. EDT
June 30:	10:30 a.m. and 1:30 p.m. EDT
July 5:	10:30 a.m. and 1:30 p.m. EDT
July 15:	1:00 p.m. EDT

Also on July 5, NASA Television will replay the May 18 press briefing with panelists Dr. Eugene Shoemaker, Dr. Heidi Hammell, Dr. Hal Weaver, Dr. Lucy McFadden and Dr. Melissa McGrath.

NASA TV is carried on Spacenet 2, transponder 5, channel 9, 69 degrees West, transponder frequency is 3880 MHz, audio subcarrier is 6.8 MHz, polarization is horizontal.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

For Release

June 27, 1994

Donald Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

James H. Wilson
Jet Propulsion Laboratory, Pasadena, Calif.
(Phone: 818/354-5011)

NOTE TO EDITORS: N94-47

NEW GALILEO ASTEROID MOON IMAGES AVAILABLE

The highest-resolution images of the recently discovered moon of the asteroid Ida have been released by NASA. The pictures were taken by NASA's Galileo spacecraft as it flew by the asteroid on August 28, 1993, and were played back by the spacecraft in early June 1994.

The images include a higher-resolution version of a picture of the asteroid moon released in March 1994. The illuminated and dark parts of the moon are shown in separate pictures.

Black and white images are available to news media from NASA's Broadcast and Imaging Branch. To obtain images, please fax your request to the Branch at 202/358-4333. The photo numbers are: H-94-181 and H-94-182.

The images also are available to the general public via Internet. Using the World Wide Web system, they may be accessed at the address: http://www.jpl.nasa.gov. They also are available via anonymous file transfer protocol (ftp) to the address jplinfo.jpl.nasa.gov. Users with a computer and modem may call 818/354-1333.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Donald Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

For Release

June 27, 1994

Diane Ainsworth
Jet Propulsion Laboratory, Pasadena, Calif.
(Phone: 818/354-5011)

RELEASE: 94-104

ULYSSES STARTS PRIMARY MISSION AT SUN

The Ulysses spacecraft became the first robotic exploration vehicle in history to reach a polar region of the Sun when it passed over the Sun's southern polar area June 26 after a journey of almost four years from Earth.

The spacecraft, built by the European Space Agency (ESA), will now climb to a position 70 degrees south of the Sun's equator to begin a four-month study of the complex force at work in the polar region. Ulysses was deployed from the Space Shuttle Discovery in October 1990. In February 1992, Ulysses spent nearly 11 days exploring unknown regions of Jupiter before gaining enough momentum to loop out of the ecliptic and on an orbit that passes over the poles of the Sun.

Scientists are elated to be able, finally, to carry out observations in the Sun's polar regions, said U.S. Project Scientist Dr. Edward J. Smith of NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif. "We have been like explorers confined to travel near the Earth's equator without being able to journey to the arctic regions."

"For a long time, we have suspected that much of the solar phenomena studied at, and near, the Earth was controlled by conditions in the Sun's polar regions," added Dr. Richard G. Marsden, ESA project scientist. "But never before have we been able to observe those processes."

The lack of knowledge about these vital regions of the Sun has resulted in large part from the limited view that Earth-based instruments or spacecraft orbiting the Earth have had of the Sun. In addition, many complex solar phenomena cannot be observed remotely, but require direct measurements. The advance of space technology has made it possible in the last few decades to send

- more -

proper instrumented robotic spacecraft such as Ulysses to previously inaccessible regions to make those direct measurements.

The polar regions of the Sun -- although mysterious in many ways -- have long captivated scientists' interest.

"The existence of a global magnetic field means that the Sun has magnetic poles much like the Earth," Smith said. "However, the properties of the polar magnetic fields, which switch polarity every 11 years in conjunction with the sunspot cycle, are poorly understood. Nevertheless, their existence introduces a basic north-south asymmetry into the solar atmosphere and space surrounding the Sun."

A better understanding of the Sun's magnetic field will be important, the scientists contended, because magnetic fields play a key role in the physics of the Sun's outer atmosphere -- called the corona -- and its extension outward into space as the so-called solar wind.

"The characteristic structure of the corona is imposed by the Sun's magnetic field," Smith said. "Furthermore, the source of the heat which creates the corona is unknown, but it is generally believed to be energy originally stored in the Sun's twisted and irregular magnetic fields."

Whatever the heat source may be, scientists think the corona is generally too hot to be restrained by even the massive gravity field of the Sun. Unless the magnetic field can hold back the coronal gas, that gas flows outward into space as the solar wind picks up speed. The solar wind is known to reach velocities of about a million miles per hour.

On the other hand, Smith added, if magnetic fields are directed outward from the Sun, they can channel the flow and assist in the escape and acceleration of the coronal gas. Coronal holes, regions of the corona which appear to be dark compared to the rest of the corona, are known sources of the solar wind.

Although these general observations are clear, many details remain obscure and will become the focus of Ulysses measurements, Smith added.

For instance, in the Sun's polar caps, the magnetic field extends outward through semi-permanent, very large coronal holes. By virtue of being directly above these sources and in the absence of complications introduced by the Sun's rotation, Ulysses is expected to contribute significant new knowledge about the escape and acceleration of the solar wind and, possibly, about the heating of the corona itself.

The magnetic field also exerts a crucial influence on matter arriving in the vicinity of the Sun from the Milky Way galaxy and, in particular, from the nearby interstellar medium.

- more -

Incoming cosmic rays, the nuclei of atoms traveling at nearly the speed of light, are subject to forces exerted by the Sun's magnetic field and its superimposed irregularities. The structure of the Sun's magnetic field is thought to favor entry of the cosmic rays by way of the polar regions.

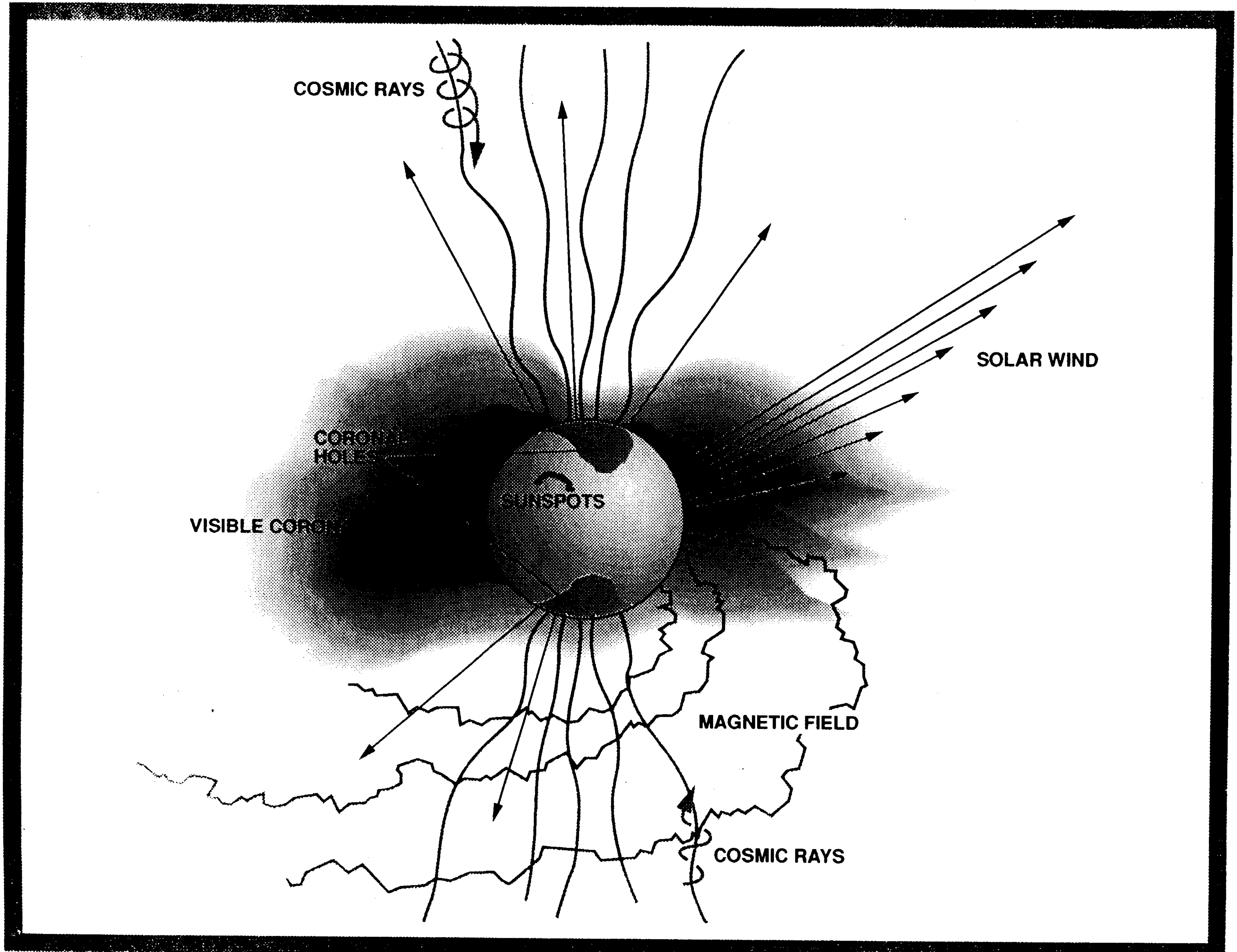
Two questions of scientific importance, Smith noted, are the extent to which the galactic cosmic rays observed at Earth use this route, and the ways in which their properties are modified as a consequence.

"We hope to gain more knowledge of the intensity and properties of the cosmic rays far from the Sun, something that is presently unknown," Smith said. "The Ulysses mission will be able to shed new light on these long-standing riddles, as the instruments on board simultaneously measure the magnetic field and the properties of the solar wind and the cosmic rays."

The Ulysses mission is managed jointly by the European Space Agency and NASA to study the regions over the Sun's poles. JPL oversees the U.S. portion of the mission for NASA's Office of Space Science, Washington, D.C.

- end -

NOTE TO EDITORS: A videotape illustrating this news release is available to news media representatives by faxing the Broadcast and Imaging Branch on 202/358-4333.


COSMIC RAYS
SOLAR WIND
SUNSPOTS
MAGNETIC FIELD
COSMIC RAYS

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Donald Savage
Headquarters, Washington, D.C.
(Phone: 202/358-1547)

Jim Doyle
Jet Propulsion Laboratory, Pasadena, Calif.
(Phone: 818/354-5011)

For Release
June 28, 1994

RELEASE: 94-105

VENUS STILL GEOLOGICALLY ACTIVE, MAGELLAN FINDS

The planet Venus is still geologically active in places, even though radar images of its surface indicate that little has changed in the past half-billion years, a scientist working on data from NASA's Magellan mission has found.

Dr. Suzanne Smrekar, a geophysicist at NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif., said her studies, based on Magellan spacecraft altimetry and gravity data, suggest that there are at least two, and possibly more, active hot spots on Venus.

Her paper, entitled "Evidence for Active Hotspots on Venus from Analysis of Magellan Gravity Data," is to be published later this year in the science publication, Icarus. Smrekar earlier presented her findings before a meeting of the Lunar and Planetary Science conference in Houston, Texas.

The Magellan spacecraft went into orbit around Venus in August of 1990 and over the next two years mapped about 98 percent of the planet's surface with imaging radar. It then began to gather gravity data to help scientists develop a model of the planet's interior.

Gravity is measured using only the spacecraft's radio signal. This technique allows ground controllers to measure the spacecraft's speed in orbit as it increases in velocity over regions of high density or slows down over regions of lesser density. Magellan's altimetry instrument measured the height of features on the surface of the planet.

The gravity data showed evidence of "top loading" and "bottom loading" at several locations, Smrekar said. Top loading is evidence of a large mass, such as a mountain or volcano, pushing down on the crustal plate. At hot spots, bottom loading indicates an upwelling of less dense and, therefore, hotter material beneath the surface.

- more -

"The matter rises and is pushed upward because it is hot and thus less dense," she said. "As it nears the surface, it produces volcanism." The mechanisms are similar to those which occur on Earth and which produce volcanoes like those on Hawaii.

Earlier data from the spacecraft's imaging radar showed that much of the surface of Venus had been covered in the past by lava flows.

Smrekar said two regions on Venus -- Atla Regio and Bell Regio -- exhibited clear signatures of both bottom and top loading of the elastic surface.

The signatures from the data are indicative of an active hot spot at Atla Regio, Smrekar said. Although the loading response is less clear, the data from Western Eistla and Beta Regio also support the interpretation that those areas are underlain by large, hot areas, probably due to active plumes in the mantle beneath the planet's crust.

At Bell Regio, Smrekar found indications of a late, possibly inactive, evolutionary stage of a low-density layer that is no longer very hot.

"These early results from a survey of four major volcanic swells on Venus reveal hot spots in different stages of evolution," Smrekar noted in her paper. "Analysis confirms that the Beta, Atla and Western Eistla regions are active hot spots."

Smrekar said future studies of those areas and other possible hot spots on Venus would continue to improve scientists' understanding of the evolution of hot spots on both Venus and Earth.

Her work at JPL was done under contract to NASA's Office of Space Science, Washington, D.C.

- end -

NOTE TO EDITORS : A four-part image depicting gravity results at Venus is available by faxing your request to the Headquarters Broadcast and Imaging Branch on 202/358-4333. The photo numbers are: B & W: 94-H-179; Color: 94-HC-167.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

For Release

Laurie Boeder
Headquarters, Washington, D.C.
(Phone: 202/358-1600)

June 29, 1994

Release: 94-106

NASA CHIEF HAILS HOUSE VOTE PRESERVING SPACE STATION

Daniel S. Goldin, Administrator of NASA, issued the following statement in reaction to today's vote in the House of Representatives which defeated an amendment to terminate the Space Station program:

The House of Representatives made a courageous decision to continue to build the International Space Station. It was a vote for America and for the American people, and a vote for our future.

This victory belongs to the President and the Vice President. President Clinton's leadership and the unprecedented effort by Vice President Gore carried the day. Chairman Brown and Representative Walker worked long and skillfully on our behalf.

This is a new space station, made bigger, better, and more powerful and more capable by our collaboration with our international partners in Russia, Europe, Canada and Japan. It's a stronger program, guided by a restructured managment team which is keeping the program on track, on schedule and on cost.

The budget passed today by the House provides for a balanced space and aeronautics program. I am committed to maintaining that balance, and will continue to work with the Congress to ensure that NASA continues to pursue bold, cutting edge programs that will deliver to the American people.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
202 358-1600

Sarah Keegan
Headquarters, Washington D.C.
(Phone: 202/358-1547)

Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

For Release

June 30, 1994

RELEASE: 94-107

HUBBLE TECHNOLOGY CONTRIBUTES TO IMPROVED BREAST BIOPSIES

A new, non-surgical and much less traumatic breast biopsy technique, based on technology developed for NASA's Hubble Space Telescope, is now saving women time, pain, scarring, radiation exposure and money, according to NASA officials.

Radiologists predict that the new technique -- known as stereotactic large-core needle biopsy -- will reduce national health care costs by approximately $1 billion annually. The new technique is replacing surgical biopsy as the technique of choice, in many cases. Performed with a needle instead of a scalpel, it leaves a small puncture wound rather than a large scar. The patient is conscious under local anesthesia compared to being unconscious in surgery.

The new technique involves a NASA-driven improvement to the digital imaging technology known as a Charge Coupled Device or CCD. CCDs are high tech silicon chips which, unlike photographic film, convert light directly into an electronic or digital image. This image can be manipulated and enhanced by computers. For the last ten years, CCDs have been almost routinely used to observe stars, galaxies, and other astronomical objects in visible and ultraviolet light.

In the breast imaging system, a special phosphor enables the new CCD to convert X-rays to visible light, allowing the system to "see" with X-ray vision. The thinned and highly sensitive CCD -- which was not commercially available prior to Hubble's development -- is now leading the field of digital breast imaging technology, according to medical specialists.

-more-

"The woman who has gone through a needle localization procedure and formal surgical biopsy on a prior occasion and now comes in to have the same thing done, but has it done as a stereotactic biopsy, is about the most appreciative patient you can imagine, because you've taken a long, drawn-out, anxiety-ridden and expensive event and made it shorter, easier to schedule, more comfortable. She has no surgical wound," explained Dr. David Dershaw, Director of Breast Imaging at Memorial Sloan-Kettering Cancer Center in New York. (His comments are in patient information materials of the LORAD Corp., Danbury, Conn., which produces breast imaging equipment.)

The technology breakthrough came when scientists at NASA's Goddard Space Flight Center, Greenbelt, Md., developing the Space Telescope Imaging Spectrograph (STIS) -- due to be installed on Hubble in1997 -- realized that existing CCD technology could not meet the instrument's demanding scientific requirements.

NASA contracted with Scientific Imaging Technologies, Inc., (SITe), of Beaverton, Ore., to develop a more sensitive CCD and lower manufacturing costs. After meeting NASA's rigorous scientific and spaceflight requirements, the company then applied its new knowledge to manufacturing CCDs for the digital spot mammography market. The result is a device that images suspicious breast tissue more clearly and efficiently than is possible with conventional X-ray film screen technology. What made the transfer of knowledge possible was the common imaging requirements of both astronomy and mammography: high resolution to see fine details, wide dynamic range to capture in a single image structures spanning many levels of brightness, and low light sensitivity to shorten exposures and reduce X-ray dosage.

SITe's CCD for digital breast imaging is virtually identical to the CCD developed for Hubble, said William Stephens, Chief Executive Officer of SITe. Approximately 350 digital breast imaging units containing SITe's thinned CCD already are in use, said Anne Smith, Marketing and Communications Manager for the LORAD Corp., which uses the STIS-like CCDs in its breast imaging equipment, and many more are on order. Currently, digital breast imaging is most often associated with stereotactic biopsies, but by mid-1995, full digital breast units should be available for routine mammographies.

In the new non-surgical technique, the CCD is part of a digital camera system that "sees" the suspicious breast tissue. A needle extracts the tissue. The patient lies face down with one breast protruding through an opening in a specially designed table. The imaging device and needle are mounted under the table.

The radiologist locates the suspected abnormality with the stereotactic X-ray imaging device by taking images of the suspected mass from two different angles. The computer finds the coordinates of the abnormality based on those two images, and the radiologist extracts a tiny sample of it with the needle. The tiny puncture wound is covered with a small bandage, and the patient can walk out of the office minutes after the procedure and resume normal activities.

More than 500,000 American women undergo breast biopsies each year. While 80 percent of the suspicious masses are benign, this cannot be determined without a biopsy. The traditional surgical technique involves running a guide wire into the breast to pinpoint the mass, surgically following the wire and digging into the breast to extract a tissue sample. With the traditional surgical biopsy, recuperation is about one week and involves a significant amount of pain, suturing and scarring, doctors say.

Although stereotactic location is also possible with X-ray film technique, radiologists say the new digital imaging device exposes patients to only half the radiation of the conventional X-ray film method. Unlike the X-ray film method, which radiates the entire breast, digital imaging exposes only a small portion of the breast to radiation. Also unlike X-ray film, which holds "frozen" pictures, digital images can be computer-enhanced to sharpen details. No film or plates must be processed, allowing patients to be evaluated in near real time.

"In addition to exposing patients to about half the radiation, digital breast imaging also approaches real time, cutting down procedure time by one-half to one-third," said Dr. Dershaw. "It's more cost effective."

Studies show that the new procedure is just as effective as traditional surgery. While traditional surgery costs about $3,500, core biopsy runs about $850. Sampling suspicious tissue now can be done in a radiologist's office.

The digital images, which are stored on computer disks, may be downloaded instantly to distant experts via computer networks, cellular signals or satellites, Stephens said. The digital image acquisition is almost foolproof, he explained, virtually eliminating re-takes and additional radiation exposure.

"The image quality is much better because the signal-to-noise ratio is better with CCDs," explained Dr. Hans Roehrig, Research Professor of Radiology and Optical Science at the University of Arizona. "You don't get the granularity that you do with X-ray film, which causes the signal-to-noise ratio of the film to be poor."

-more-

"Stereotactic biopsies also were done before the advent of the thinned CCDs, but they took a long time," said Dr. Roehrig. "First, two X-ray pictures of the abnormality had to be taken. The pictures had to be developed in the darkroom, which takes about three minutes. Then, measurements had to be taken on the film images and run through a computer in order to perform triangulation to determine the coordinates [of the suspected abnormality]. The process of taking pictures, developing the film and locating the coordinates of the abnormal tissue mass typically takes about fifteen to twenty minutes, and during this whole time, the patient -- still at the machine -- cannot move. Now, in near real time, the entire process of locating the mass can take as little as five minutes and is much more comfortable for the patient."

The new biopsy technique, made possible by the CCDs developed for Hubble Space Telescope, will spare millions of women pain, scars and radiation exposure, will lead to much faster recuperation and will save billions in health care costs.

-end-

NOTE TO EDITORS: Color and B&W images are available to news media from NASA's Broadcast and Imaging Branch. To obtain images, please fax your request to the Branch at 202/358-4333. The photo numbers for the color images are 94-HC-168 and 94-HC-169; and for the B&W images, the numbers are 94-H-180 and 94-H-183.